Service Manual

AVEA
Ventilator Systems

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Revision History

Date	Revision	Pages	Changes
August 2002	Revision A	All	Released Engineering Document Control ECO
July 2003	Revision B	All	Add Exception button and Exception screen to Error Log screen. Add list of error codes. Add OVP kits & instructions. Add Software upgrade instructions. Add Heliox Smart connector instructions. Add Compressor upgrade instructions. Add cart instructions (both). Add external battery pack instructions. Add Insp & Exp transducer Cal instructions. Add ref to Communications Protocol. Add unpacking & setup instructions. Reorganize chapters, add chapter 3, add chapter 5 (OVP), add software upgrade info (chapter 6), add chapter 9, add chapter 10, add appendix D.

Notices

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Trademark Notices

AVEA® is a registered trademark of VIASYS Healthcare, Critical Care Division in the U.S. and some other countries. All other brand names and product names mentioned in this manual are trademarks, registered trademarks, or trade names of their respective holders.

EMC Notice

This equipment generates, uses, and can radiate radio frequency energy. If not installed and used in accordance with the instructions in this manual, electromagnetic interference may result. The equipment has been tested and found to comply with the limits set forth in EN60601-1-2 for Medical Products. These limits provide reasonable protection against electromagnetic interference when operated in the intended use environments described in this manual.

The ventilator has been tested to conform to the following specifications:

MIL-STD-461D:1993, MIL-STD-462D:1993, EN55011:1991, IEC 1000-4-2:1994, IEC 1000-4-3:1994, IEC 1000-4-4:1994, IEC 1000-4-5:1994, QUASI-STATIC:1993

This ventilator is also designed and manufactured to comply with the safety requirements of IEC 601-1, IEC 601-2-12, CAN/CSA-C22.2 No. 601.1-M90, and UL 2601-1.

MRI Notice

This equipment contains electromagnetic components whose operation can be affected by intense electromagnetic fields.

Do not operate the ventilator in an MRI environment or in the vicinity of high-frequency surgical diathermy equipment, defibrillators, or short-wave therapy equipment. Electromagnetic interference could disrupt the operation of the ventilator.

Intended Use Notice

The AVEA Ventilators are designed to provide ventilator support for the critical care management of infant, pediatric or adult patients with compromised lung function. They are intended to provide continuous respiratory support in an institutional health care environment. **They should only be operated by properly trained clinical personnel, under the direction of a physician.**

Regulatory Notice

Federal law restricts the sale of this device except by or on order of a physician.

IEC Classification

Type of Equipment: Medical Equipment, Class 1 type B

Adult/Pediatric/Infant Lung Ventilator

Declaration of Conformity Notice

This medical equipment complies with the Medical Device Directive, 93/42/EEC, and the following Technical Standards, to which Conformity is declared:

EN60601-1
EN60601-1-2
ISO 9001, EN 46001

EU Notified Body:

BSI (Reg. No. 0086)

Tradenames:

AVEA Ventilator

CE

0086

If you have a question regarding the Declaration of Conformity for this product, please contact VIASYS Healthcare, Critical Care Division at the number given in Appendix A.

Warranty

THE AVEA® ventilator systems are warranted to be free from defects in material and workmanship and to meet the published specifications for TWO (2) years or 16,000 hours, whichever occurs first.

The liability of VIASYS Healthcare, Critical Care Division, (referred to as the Company) under this warranty is limited to replacing, repairing or issuing credit, at the discretion of the Company, for parts that become defective or fail to meet published specifications during the warranty period; the Company will not be liable under this warranty unless (A) the Company is promptly notified in writing by Buyer upon discovery of defects or failure to meet published specifications; (B) the defective unit or part is returned to the Company, transportation charges prepaid by Buyer; (C) the defective unit or part is received by the Company for adjustment no later than four weeks following the last day of the warranty period; and (D) the Company's examination of such unit or part shall disclose, to its satisfaction, that such defects or failures have not been caused by misuse, neglect, improper installation, unauthorized repair, alteration or accident.

Any authorization of the Company for repair or alteration by the Buyer must be in writing to prevent voiding the warranty. In no event shall the Company be liable to the Buyer for loss of profits, loss of use, consequential damage or damages of any kind based upon a claim for breach of warranty, other than the purchase price of any defective product covered hereunder.

The Company warranties as herein and above set forth shall not be enlarged, diminished or affected by, and no obligation or liability shall arise or grow out of the rendering of technical advice or service by the Company or its agents in connection with the Buyer's order of the products furnished hereunder.

Limitation of Liabilities

This warranty does not cover normal maintenance such as cleaning, adjustment or lubrication and updating of equipment parts. This warranty shall be void and shall not apply if the equipment is used with accessories or parts not manufactured by the Company or authorized for use in writing by the Company or if the equipment is not maintained in accordance with the prescribed schedule of maintenance.

The warranty stated above shall extend for a period of TWO (2) years from date of shipment or 16,000 hours of use, whichever occurs first, with the following exceptions:

1. Components for monitoring of physical variables such as temperature, pressure, or flow are warranted for ninety (90) days from date of receipt.
2. Elastomeric components and other parts or components subject to deterioration, over which the Company has no control, are warranted for sixty (60) days from date of receipt.
3. Internal batteries are warranted for ninety (90) days from the date of receipt.

The foregoing is in lieu of any warranty, expressed or implied, including, without limitation, any warranty of merchantability, except as to title, and can be amended only in writing by a duly authorized representative of the Company.

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Chapter 1 Introduction

Safety Information

Please review the following safety information prior to operating the ventilator. Attempting to operate the ventilator without fully understanding its features and functions may result in unsafe operating conditions.

Warnings and Cautions which are general to the use of the ventilator under all circumstances are included in this section. Some Warnings and Cautions are also inserted within the manual where they are most meaningful.

Notes are also located throughout the manual to provide additional information related to specific features.

If you have a question regarding the installation, set up, operation, or maintenance of the ventilator, contact VASYS Healthcare Customer Care as shown in Appendix A, Contact & Ordering Information.

Terms

WARNINGS	identify conditions or practices that could result in serious adverse reactions or potential safety hazards.
CAUTIONS	identify conditions or practices that could result in damage to the ventilator or other equipment.
NOTES	identify supplemental information to help you better understand how the ventilator works.

Warnings

Warnings and Cautions appear throughout this manual where they are relevant. The Warnings and Cautions listed here apply generally any time you work on the ventilator.

- Alarm loudness must be set above ambient sound in order to be heard.
- Due to possible explosion hazard, the ventilator should not be used in the presence of flammable anesthetics.
- An audible alarm indicates an anomalous condition and should never go unheeded.
- Anti-static or electrically conductive hoses or tubing should not be used within the patient circuit.
- If a mechanical or electrical problem is recognized while running the Operational Verification Tests, or while operating the ventilator, the ventilator must be removed from use until the problem has been identified and resolved.
- The functioning of this equipment may be adversely affected by the operation of other equipment nearby, such as high frequency surgical (diathermy) equipment, defibrillators, short-wave therapy equipment, “walkie-talkies,” or cellular phones.
- Water in the air supply can cause malfunction of this equipment.
- Do not block or restrict the Oxygen bleed port located on the instrument back panel. Equipment malfunction may result.

- Electric shock hazard – Ensure the ventilator is disconnected from the AC power supply before performing and repairs or maintenance. When you remove any of the ventilator covers or panels, immediately disconnect the internal battery “quick release” connector before working on the ventilator. If the ventilator has an external battery installed, ensure that the external battery is unplugged from the rear panel before proceeding
- A protective ground connection by way of the grounding conductor in the power cord is essential for safe operation. Upon loss of protective ground, all conductive parts including knobs and controls that may appear to be insulated, can render an electric shock. To avoid electrical shock, plug the power cord into a properly wired receptacle, use only the power cord supplied with the ventilator, and make sure the power cord is in good condition.

The following warnings must be read and understood before performing the procedures described in this manual.

- Under no circumstances should this medical device be operated in the presence of flammable anesthetics or other volatile materials due to a possible explosion hazard.
- Liquid spilled or dripped into the unit may cause damage to the unit or result in an electrical shock hazard.
- Oxygen vigorously accelerates combustion. To avoid violent ignition, do not use any gauges, valves, or other equipment that has been exposed to oil or grease contamination.
- Do not use this device if any alarm/alert function is inoperative. To do so could result in a malfunction without warning, possibly resulting in personal injury, including death or property damage.
- All tubing and fittings used to connect high pressure gas from the source to the test equipment and from the test equipment to the device being tested must be capable of withstanding a minimum supply pressure of 100 psi (7.03 kg/cm2). The use of tubing and fittings not capable of withstanding this pressure could cause the tubing to rupture, resulting in personal injury or property damage.
- When verifying the operation of this medical device, do not breathe directly from the machine. **Always** use a fresh bacterial filter and test circuit. Failure to do so may constitute a hazard to the health of the service person.
- If any of the procedures outlined in this document cannot be verified, do not use this device and refer it to VIASYS Healthcare or a VIASYS Healthcare Authorized Service Facility or a VIASYS Healthcare Trained Hospital Service Technician.

Cautions

The following cautions apply any time you work with the ventilator.

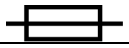
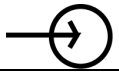
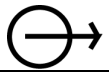
- Ensure that the voltage selection and installed fuses are set to match the voltage of the wall outlet, or damage may result.
- A battery that is fully drained (i.e. void of any charge) may cause damage to the ventilator and should be replaced.
- All accessory equipment that is connected to the ventilator must comply with CSA/IEC601/UL2601.
- To avoid damage to the equipment, clean the air filter regularly.

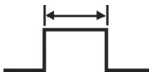
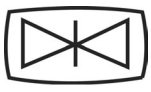
The following cautions apply when cleaning the ventilator or when sterilizing ventilator accessories.

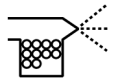
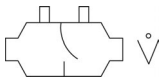
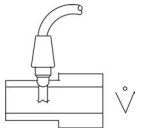
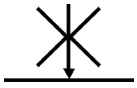
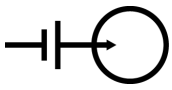
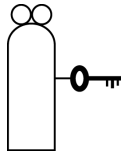
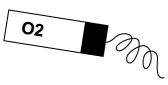
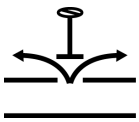
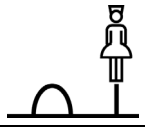
- Do not sterilize the ventilator. The internal components are not compatible with sterilization techniques.
- Do not gas sterilize or steam autoclave tubing adapters or connectors in place. The tubing will, over time, cause poor connection and possible leaks.
- DO NOT submerge the ventilator or pour cleaning liquids over or into the ventilator.
- Do not use MEK, Trichloroethylene or similar solutions as damage to surface may result. Do not allow any liquid to spill or drip into the ventilator.
- Circuit boards are subject to damage by static electricity. Do not touch components, circuit, or connector fingers with hands. Handle only by edges.

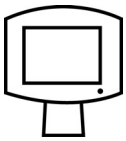
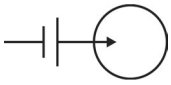
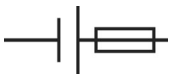
Equipment Symbols

The following symbols may be referenced on the ventilator or in accompanying documentation

Symbol	Source/Compliance	Meaning
	Symbol #03-02 IEC 60878	Indicates ATTENTION, consult ACCOMPANYING DOCUMENTS
	Symbol #5016 IEC 60417	This symbol indicates a FUSE.
	Symbol #5034 IEC 60417 Symbol #01-36 IEC 60878	This symbol indicates INPUT.
	Symbol #5035 IEC 60417 Symbol #01-37 IEC 60878	This symbol indicates OUTPUT
	Symbol #5019 IEC 60417 Symbol #01-20 IEC 60878	This symbol indicates protective EARTH (ground).
	Symbol #5021 IEC 60417 Symbol # 01-24 IEC 60878	This symbol indicates the EQUIPOTENTIAL connection used to connect various parts of the equipment or of a system to the same potential, not necessarily being the earth (ground) potential (e.g., for local bonding).
	Symbol # 5333 IEC 60417 Symbol #02-03 IEC 60878	This symbol indicates TYPE B equipment, which indicates equipment that provides a particular degree of protection against electric shock, particularly with regards to allowable leakage current and reliability of the protective earth connection.
	Symbol #5032 IEC 60417 Symbol #01-14 IEC 30878	This symbol is located on the rating plate. It indicates the equipment is suitable for alternating current.
	Symbol #5007 IEC 60417 Symbol #01-01 IEC 60878	Indicates ON (Power)
	Symbol #5008 IEC 60417 Symbol #01-02 IEC 60878	Indicates OFF (Power)
 ACCEPT	Symbol #0651 ISO 7000	Horizontal return with line feed. Indicates ACCEPT entered values for a specific field.
	VIASYS Healthcare Symbol	Indicates PATIENT EFFORT
	VIASYS Healthcare symbol	Indicates MANUAL BREATH
	VIASYS Healthcare Symbol	MAIN SCREEn
	Symbol #417 IEC 5102	EVENT READY

	VIASYS Healthcare Symbol	MODE
	VIASYS Healthcare Symbol	ADVANCED SETTINGS
	VIASYS Healthcare Symbol	SET-UP for patient Data
	VIASYS Healthcare Symbol	SiPAP Duration
	MDD Directive 93/42/EEC	CE Mark
	Symbol #5307 IEC 60417	ALARM RESET
	Symbol #5319 IEC 60417	ALARM SILENCE
	VIASYS Healthcare symbol	ADULT patient
	VIASYS Healthcare symbol	PEDIATRIC patient
	VIASYS Healthcare symbol	NEONATAL (Infant) patient
CANCEL	Graphical Symbol in general use internationally for “DO NOT”	CANCEL, do not accept entered values.
	VIASYS Healthcare symbol	Select DISPLAYED SCREEN function.
	Symbol 5467 IEC 60417	FREEZE the current display.
	VIASYS Healthcare symbol	Enable the ALARM LIMITS screen
	VIASYS Healthcare symbol	This symbol indicates a CONTROL LOCK.

	VIASYS Healthcare symbol	NEBULIZER port
	VIASYS Healthcare symbol	Increase OXYGEN
	VIASYS Healthcare symbol	PRINT SCREEN
	VIASYS Healthcare symbol	SUCTION port
	VIASYS Healthcare symbol	VARIABLE ORIFICE FLOW SENSOR connection
	VIASYS Healthcare symbol	HOT WIRE FLOW SENSOR connection
	VIASYS Healthcare symbol	ANALOG IN/OUT connection
	VIASYS Healthcare symbol	Display the MAIN SCREEN
	VIASYS Healthcare symbol	DO NOT BLOCK PORT
	VIASYS Healthcare symbol	EXTERNAL BATTERY connection
	VIASYS Healthcare symbol	Indicates GAS ID port
	VIASYS Healthcare symbol	OXYGEN SENSOR connection
	VIASYS Healthcare symbol	OVERPRESSURE relief
	VIASYS Healthcare symbol	REMOTE NURSE CALL connection

	VIASYS Healthcare symbol	UNIVERSAL INTERFACE MONITOR connection
	VIASYS Healthcare Symbol	This symbol indicates an EXTERNAL BATTERY INPUT
	VIASYS Healthcare Symbol	This symbol indicates an INTERNAL BATTERY FUSE
	VIASYS Healthcare Symbol	This symbol indicates ALARM LOUDNESS

Chapter 2 Theory of Operation

General Description

AVEA is a software driven, servo-controlled ventilator designed to meet the requirements of neonate to adult patients. The design intent of the device is to provide a high performance software-driven gas delivery engine, which is capable of providing a full range of volume and pressure ventilation including dual limb NIPPV. This affords the flexibility of developing new modes of ventilation with no impact to the basic gas delivery engine. In addition, the device will contain a graphical user interface (GUI) that utilizes a 12.1-inch SVGA color LCD screen with integral touch screen. The GUI will be used to change settings and operating parameters as well as providing real time waveforms, digital monitors, and alarms. The device will also contain an optional internal battery backed up compressor, which will allow the device to be used for inter-hospital transport as well as backup in case of loss of hospital AC power.

Two models of the device will initially be released as shown in table 2.1 based on the same basic platform. Additional models may be developed in the future by adding or removing software and/or hardware features to the existing platform.

Table 2.1 AVEA Features

FEATURES	MODEL	
	AVEA 200	*AVEA 300*
Standard Features		
Patient Range	Neonate - Adult	Neonate - Adult
Display (12.1" CSVGA)	Active	Active
Prox. Flow Monitoring	Hot wire (1)	Hot wire(2)
Prox. Pres. Monitoring	N/A	Std
Internal Battery	Std	Std
Software Features		
All Modes of Ventilation	Std	Std
Waves	Std	Std
Loops	Std	Std
Trends & Chart	Std	Std
Maneuvers	Basic Maneuvers	Std
Factory Installed Options		
Internal Compressor	Opt	Std
Enhanced Monitoring	N/A	Std
Heliox	Opt	Std
Stand		
High End Stand	N/A	Std
Mid Level Stand	Std	N/A
External Batteries (17 AHr @ 24 VDC)	Only with Customer Stand	Opt
Tank Holder	Opt	Opt

(1) Standard hot wire infant wye flow sensor only.

(2) Hot wire is the standard infant wye flow sensor. The Bicore adult and infant wye flow sensors can be used with the Enhanced Monitoring.

High Level Design

AVEA has been designed with three basic modules, the user interface module (UIM), the pneumatics module (PM), and the stand (see Figure 1). The UIM contains a graphical user interface (GUI) which utilizes a 12.1-inch SVGA color LCD screen with integral touch screen. The UIM also contains a control PCB that has two microprocessors, control and monitor. The monitor processor manages the GUI, while the control processor has the real time control system that controls all of the mechanical valves in the PM. The UIM communicates with the PM via a high-speed serial channel (HSSC). The HSSC also provides power to the UIM.

The pneumatics module (PM) contains all of the mechanical valves, sensors, analog electronics, power supply including the internal batteries, and the optional internal compressor. The pneumatics module takes high-pressure air or 80/20 heliox and oxygen from an external wall source or other high-pressure source. It filters the gas and blends them through a stepper motor controlled blender according to the front panel settings. It then delivers the appropriate pressure or volume via a high-speed proportional solenoid with flow sensor feedback. The high-speed control system occurs every 2 msec and is computed in the control microprocessor in the UIM. The delivered gas flows to the patient through a safety valve that has a mechanical over pressure relief valve as well as a sub-ambient valve. The gas is forced into the patient by closing the servo-controlled voice coil exhalation valve, which is also controlled by the control microprocessor in the UIM. The patient is allowed to exhale by the voice coil exhalation valve, which also maintains baseline pressure or PEEP. The exhaled gas exits the patient through the expiratory limb of the patient circuit to an integral heated expiratory filter to an external flow sensor and out the exhalation valve to ambient air.

The pneumatics module has several additional capabilities. First it uses either air or 80/20 heliox for an input gas, and corrects all blending, volume delivery, volume monitoring and alarming, and FiO_2 monitoring and alarming based on the correct gas density. The system knows what the gas is, by a patent pending gas ID that identifies the appropriate inlet DISS fitting with the gas that is being delivered, which creates an inherently safer system for delivering heliox. The second capability is the optional back up compressor that is battery backed up for a minimum of 30 minutes by a fully charged internal battery, which allows for uninterrupted ventilation during a loss of AC power. The third feature is the ability to monitor volume either at the expiratory limb of the machine or at the patient wye. This allows for more accurate patient monitoring especially in infants while allowing the convenience of an expiratory limb flow sensor protected by a heated filter. Finally, the fourth feature is the ability to measure tracheal and esophageal pressure, which is currently commercially available only on other VIASYS (Bear/Bird) ventilators.

The stand is used to support the ventilator at an ergonomically correct height. It may contain an optional external battery for extended use with AC power (custom stand only). It also has an optional O_2 bottle bracket so that the unit can be used without wall oxygen during inter-hospital transport. The stand does not contain active electronic or mechanical components other than the optional external batteries, which are charged when connected to A/C Power.

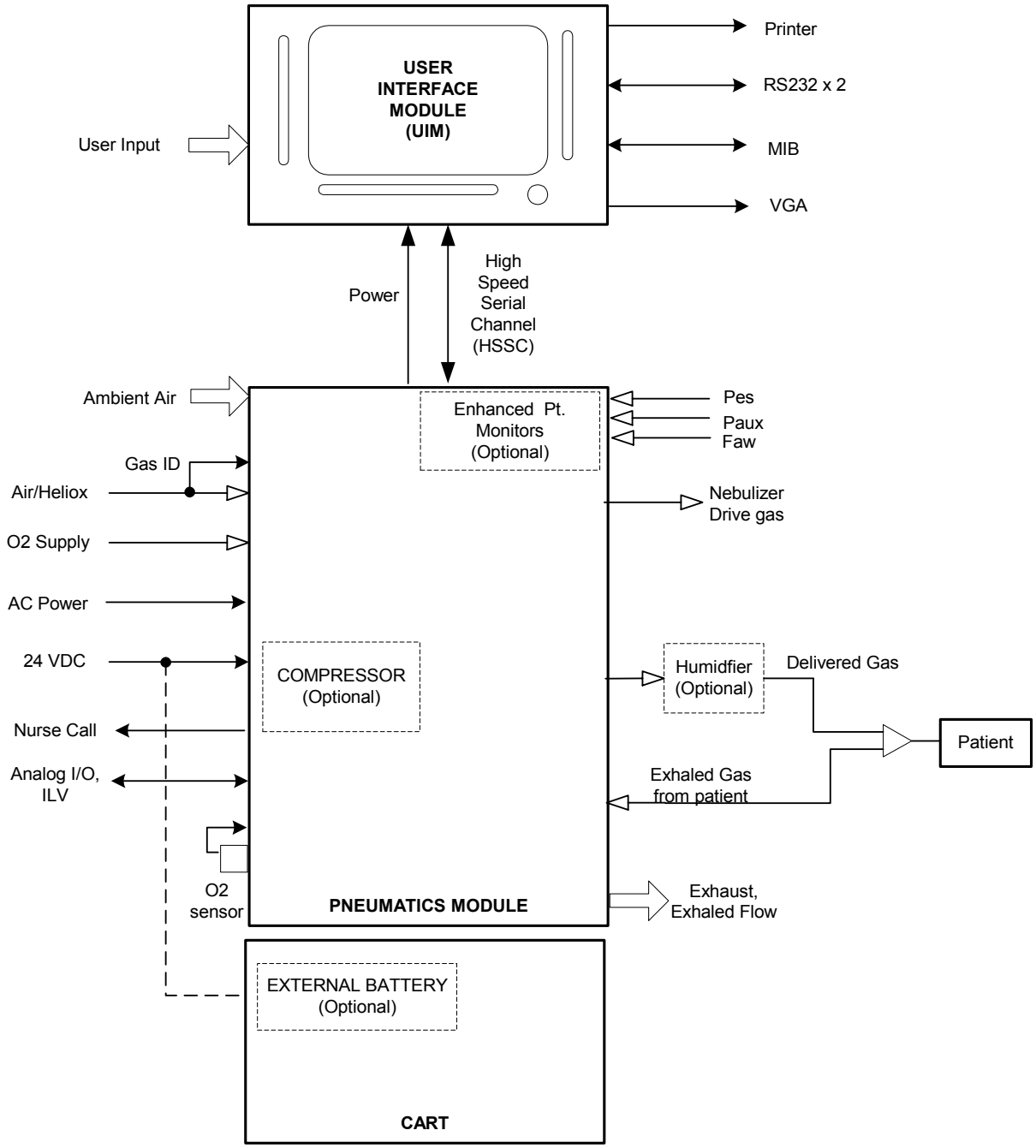


Figure 2.1 -- High End Device Modular Diagram

Detail Design

User Interface Module (UIM)

The UIM consists of a 12.1-inch, 800x600 active matrix LCD with an analog resistive touch screen overlay, a back light inverter, a set of membrane key panels, an optical encoder, and a Control PCB. Software and the touch screen provide a set of context sensitive soft keys. The membrane panel provides a set of hard (permanent) keys for dedicated functions. Selecting the function with a soft key and adjusting the setting using the optical encoder changes a parameter. The parameter is accepted or canceled by pressing the appropriate membrane key.

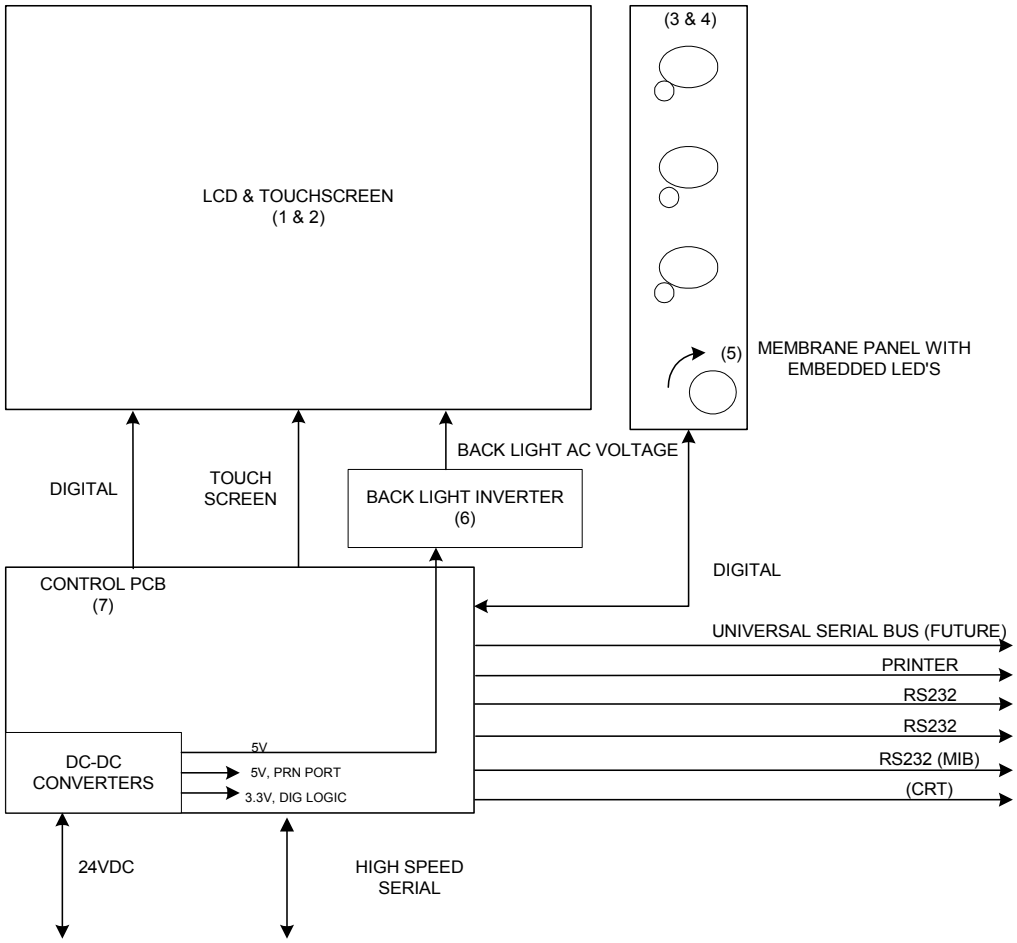


Figure 2.2 -- User Interface Design Module Block Diagram

The UIM performs all ventilator control functions, gas calculations, monitoring and user interface functions. The UIM uses a Graphical User Interface (GUI) via the active matrix SVGA LCD and resistive touch screen to provide system and patient information to the user and to allow the user to modify ventilator settings. The Control PCB (with two micro-controllers, RAM, ROM and support electronics) provides all ventilator functions. The Control micro-controller (MCU) performs all gas calculations; controls all valves, solenoids, and electronics required to deliver blended gas to the patient. The Monitor MCU handles all user interface requirements, including updating the active matrix liquid crystal display (LCD), monitoring the membrane keypad, analog resistive touch screen, and optical encoder for activity. The Monitor MCU also performs all the input/output functions of the UIM, including RS-232, printer, video output, and IEEE 1073 Medical Information Bus (MIB)[Not currently functional]. Communication between the Control and Monitor MCU's is accomplished via an 8 bit dual port SRAM. In addition, both MPU's monitor each other and both are independently capable of activating the fail safe system.

The UIM is self-contained and is tethered to the pneumatics module with a high-speed data and power cable. All valves are contained in the pneumatics module; the control MCU controls all ventilator functions via the high-speed serial channel (HSSC). The Monitor MCU provides additional input/output functions contained in the ventilator. These functions include analog outputs, independent lung ventilation, and nurse call and are updated by the Monitor MCU via the HSSC.

Liquid Crystal Display

The liquid crystal display (LCD) provides graphical and digital feedback to the clinician. The panel is a 12.1" SVGA, 800x600 pixel, active matrix LCD. The LCD is used to implement the graphical user interface (GUI). It provides all of the adjustable controls and alarms, as well as displays waveforms, loops, digital monitors and alarm status in real time.

Touch Screen

The touch screen in conjunction with the LCD provides a set of software configurable soft keys. The software allows the keys to be context sensitive. The touch screen is a 12.1" analog resistive overlay on a piece of glass, which is placed over the LCD. It has a resolution of 1024x1024. Physically the touch screen, consists of two opposing transparent resistive layers separated by insulating spacers. Actuation brings the two opposing layers into electrical contact. The Y coordinate is determined by applying a voltage from top to bottom on the top resistive layer. This creates a voltage gradient across this layer. The point of contact forms a voltage divider, which is read by the analog-to-digital converter. The X coordinate is determined by applying a voltage from left to right on the bottom resistive layer. Again this creates a voltage gradient and the point of contact forms a divider, which is read with an analog-to-digital converter.

Membrane Panel

The membrane panel provides a set of permanent dedicated keys, which allow the clinician to change certain ventilator functions. The membrane panel will provide visual status to the clinician via embedded light emitting diodes (LEDs). The membrane panel consists of membrane switches, which are read by the monitor CPU. The switches form a matrix of rows and columns. A key closure causes an interrupt to the monitor CPU, which responds by scanning the key matrix to determine which key has been pressed.

Light Emitting Diodes (LEDs)

Some of the membrane keys require LED's to indicate when the key is active. The LED's are embedded into the membrane panels.

Optical Encoder

The optical encoder allows the clinician to change settings. The setting to be changed is selected by pressing a soft key on the LCD and then turning the optical encoder to change the value. When the encoder is rotated two pulse streams are generated, phase A and B. When the encoder is turned clockwise, phase A leads B by 90 degrees. When the direction is counter clockwise, phase B leads A by 90 degrees. The electronics uses the phase information to drive an up-down counter, which is read by the monitor CPU. The optical encoder is not interrupt-driven and therefore must be polled by the monitor CPU.

Back Light Inverter

The back light inverter converts 5 VDC into the high frequency AC voltage necessary to power the LCD back light, which is used to illuminate the LCD.

Control PCB

The control PCB consists of two micro-controllers, the control CPU and the monitor CPU, both of which are 100 MHz ELAN 410's. The control and associated circuitry (RAM, ROM, etc) micro controllers perform all ventilator control functions including the 2 msec closed loop flow control servo and the 2 msec closed loop exhalation valve control servo. The monitor micro-controller manages the GUI and performs all user input and output including the RS-232 ports, printer port, video out, and MIB port. The two processors communicate with each other via a dual port RAM. The control processor communicates with the pneumatics module via a high-speed serial channel (HSSC - 4 Mbits/sec).

Each processor has 8 Mbytes of DRAM, and one Mbyte of flash memory for program storage. In addition, the monitor circuitry also has a second one Mbyte of flash memory for saving control settings and trended data for clinical parameters. The control PCB also contains a DC-to-DC converter to regulate the incoming 24 VDC to the voltages used by the UIM. Finally, the control PCB also contains all of the circuitry necessary to scan the membrane panels, touch screen, and optical encoder, as well as the video controller necessary to drive the SVGA LCD screen.

Pneumatics Module

The pneumatics module (PM) consists of a power supply system including internal NiMH batteries, a transducer/ communication/alarm PCB (TCA PCB), the pneumatics, a heated expiratory system, a fan, an optional internal compressor, a built-in nebulizer system, and an audible alarm. The PM communicates with the UIM via the HSSC described above.

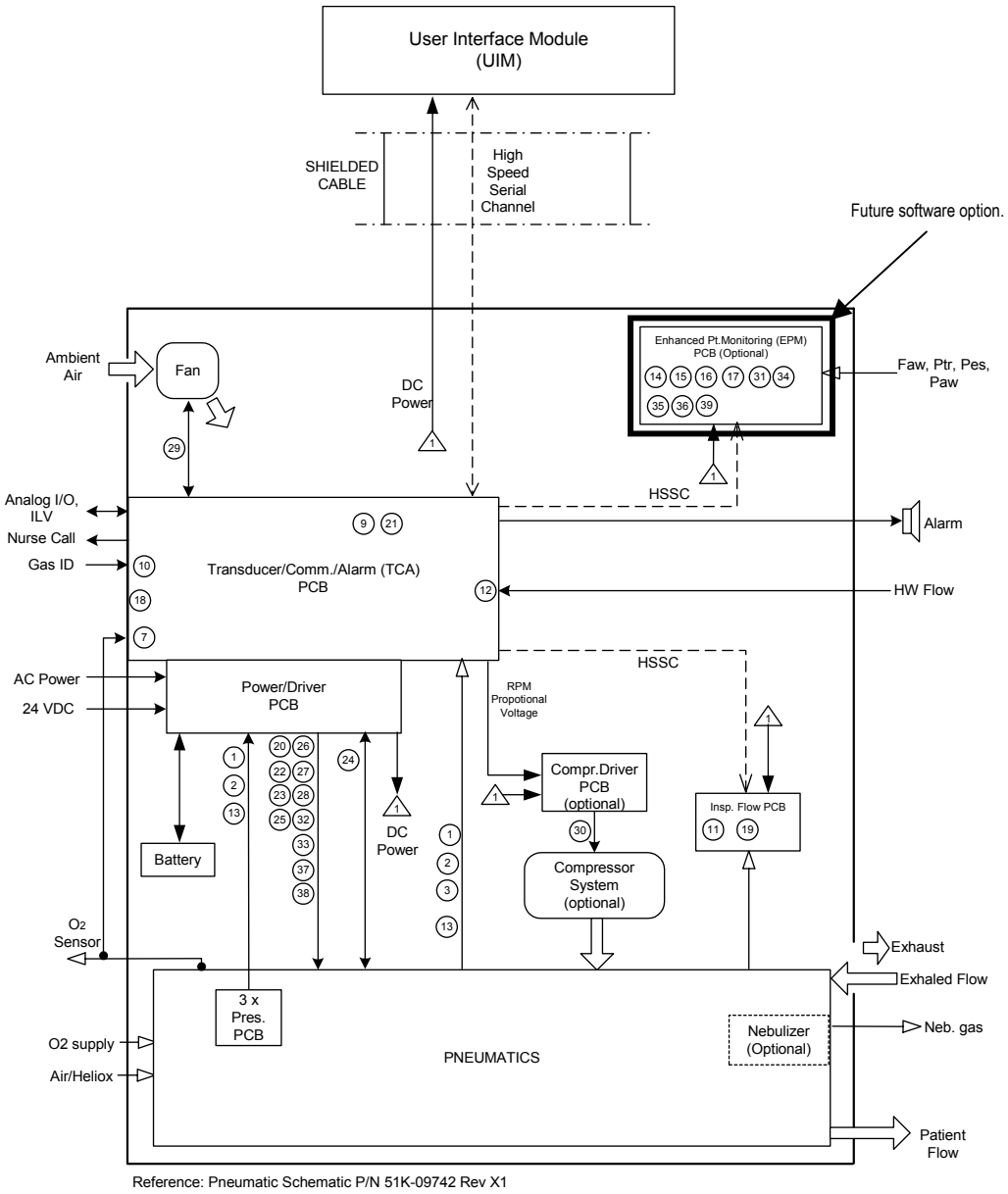


Figure 2.3 Pneumatics Module Block Diagram

Power Supply System

The power supply system, consists of a power inlet module, and a medical grade 250-watt power supply, the power driver PCB, and a set of internal 12 VDC NiMH batteries connected in series. The power inlet system accepts a standard IEC medical grade power cord and allows the system to be configured externally for use with 100 to 240 VAC 50/60 Hz power. AC power is converted to 31 VDC by the internal medical grade power supply, which is also power factor corrected. The power driver PCB converts the 31 VDC from the power supply or the 24 VDC from the internal or external batteries to the appropriate voltages used by the rest of the system. The power driver PCB also contains the charging circuit for both the internal and external batteries, as well as the drivers for the flow control, exhalation valve, and multiple solenoids. The internal 4.5 Ah NiMH batteries can power the entire system including the internal compressor for 30 minutes, or 2 hours without the compressor. With the external 17 Ah lead acid batteries combined with the internal battery powers the entire system including compressor will run for 2 hours on batteries, and 8 hours without compressor.

Transducer/Alarm PCB (TCA PCB)

The TCA PCB consists of circuitry for the audible alarm, the wye hot wire flow sensor, the gas ID, the inspiratory and expiratory pressure transducers, the source gas pressure transducers, the exhaled flow sensor, the FiO2 cell, and communications with the UIM. It also contains the nurse call, and analog input and output.

A 68HC705 micro-controller is used to generate alarm waveforms for an ASTM F1463-93 compliant alarm. A super capacitor is used to provide a minimum if 120 seconds of power without wall AC or a battery.

Analog circuitry is provided to signal condition the wye Hot Wire Flow Sensor signal and a 12 bit ADC is used to digitize the signal. A Flow Sensor Fail signal is provided to allow the Control Processor to determine when the flow sensor wire is broken. The Flow Sensor EEPROM is SPI bus compatible and is read at power up and when a Flow Sensor is connected.

The air inlet fitting contains a resistor for determining which gas source is connected to the Air inlet, Air or Heliox. The type of gas connected is determined with a resistor divider, one half of the divider is contained in a connector and the other half is located on the TCA. The resistor contained in the connector is different for each gas source and therefore produces a different voltage output from the divider. The output of the divider is read via an ADC.

Inspiratory and expiratory pressure transducers and associated signal conditioning are digitized on the TCA PCB. The control processor reads the digitized data via the HSSC. The air, oxygen, and blended gas pressure transducers and associated signal conditioning are on separate PCBs for ease of mounting. The amplified signals are cabled to the TCA where they are digitized and communicated to the control processor via the HSSC.

Exhaled flow is measured with a VARFLEX® Exhaled Flow Sensor. The VARFLEX® Flow Sensor uses a variable orifice with pressure taps on either side of the orifice. The TCA uses a low-pressure pressure transducer and analog circuitry to measure the flow proportional pressure drop across the orifice.

Integrated circuit temperature sensors are signal conditioned and digitized by the TCA electronics. The exhalation and ambient temperature sensors are cabled to the TCA PCB. The output of oxygen cell is also signal conditioned and digitized on the TCA.

There are four 10-bit analog output channels on the TCA for pressure, flow, volume, and breath phase respectively. They have a full scale of 0 to 5 VDC with 10-bit resolution. In addition, there are 8

programmable analog inputs that can be used to display external signals. They are digitized with a 10 bit DAC, and are scalable from 0 to 1VDC, 0 to 5 VDC, and 0 to 10 VDC.

Finally, there is a nurse call output that can be configured as either normally open or normally closed. The nurse call shall be activated for all medium and high priority alarms except when alarm silence is activated.

Pneumatics-Gas Delivery Engine

The Gas Delivery Engine receives and conditions supplied Oxygen, Air, or Heliox from an external and/or internal (compressor) sources. It then mixes the gas to the concentration required and delivers the desired flow or pressure to the patient.

The Gas Delivery Engine begins with the Inlet Pneumatics. The Inlet Pneumatics accepts clean O_2, Air, or Air alternate external gas; it provides extra filtration and regulates air and O_2 gas before entering the Oxygen Blender. The Oxygen Blender mixes the gases to the desired concentration before reaching the Flow Control Valve. The Flow Control Valve controls the flow rate of the gas mixture to the patient. Between the Oxygen Blender and Flow Control Valve, the Accumulator System is installed to provide peak flow capacity. The Flow Sensor provides information about the actual inspiratory flow for closed loop servo control. The gas is then delivered to the patient through the Safety/Relief Valve and Outlet Manifold.

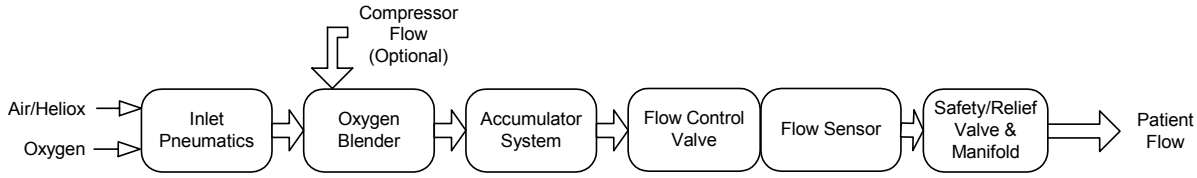


Figure 2.4 -- Gas Delivery Engine Block Diagram

Inlet System

The Inlet Pneumatics conditions and monitors the air, oxygen, and/or helium-oxygen mix supplies entering the ventilator. The Inlet Pneumatics has Inlet Filters that remove aerosol and particulate contaminants from the incoming gas supplies. The downstream Air Regulator and O_2 Relay combination is used to provide balanced supply pressure to the gas blending system. The Air Regulator reduces the air supply pressure to 11.0 PSIG and pilots the O_2 Relay to track at this same pressure. This system automatically regulates to 9.5 PSIG when the optional internal compressor is being used.

In the event the supply air pressure falls below the acceptable level, the internal compressor will be activated to automatically supply air to the blender. Without an optional internal compressor, the Crossover Solenoid opens delivering high-pressure oxygen to the Air Regulator, allowing the Air Regulator to supply regulated O_2 pressure to pilot the O_2 Relay. In addition, the Oxygen Blender simultaneously moves to the 100% O_2 position, so that full flow to the patient is maintained.

In the event of an oxygen supply pressure drop below a pressure threshold, the Crossover Solenoid stays closed, the blender moves to 21% O_2, and the regulated air pressure provides 100% air to the blending system.

Oxygen Blender

The Blender receives the supply gases from the Inlet Pneumatics System and blends the two gases to the user-selected value. It consists of three sub-systems, valve, stepper motor, and drive electronics. The Oxygen Blender PCB provides the electronics needed to control the Oxygen Blender stepper motor. The stepper motor controls the oxygen blender and is stepped in 1.8-degree increments. The Blender has a disk, which is positioned during calibration. One end of the disk will interrupt the optical interrupter when the valve position is closed and the other end will only interrupt in case the Blender goes approximately one full revolution due to loss of position. An EEPROM will be used to store the number of steps required to travel from the home position to the full open position of the valve, the PCB revision, and manufacturing date.

Accumulator

The Accumulator stores blended gas supplied from either regulated wall gas or an optional internal compressor. The accumulator provides the capability to achieve volume capacity at relatively lower pressure, resulting in lower system power requirements. It stores blended gas during patient exhalation cycles which maximizes system efficiency. The Accumulator gas pressure cycles between 3 and 11 PSIG depending on the Tidal Volume. The system efficiency is improved because a smaller compressor can be used to meet Tidal Volume while the accumulator provides the extra gas needed to meet the patient's peak flow demand. A 6-L/MIN accumulator bleed orifice allows gas concentration in the accumulator to match the oxygen blender setting in a maximum time of 1 minute. A pressure relief valve will provide protection from pressure exceeding 12 PSIG to the accumulator.

Flow Control System

The Flow Control System provides the desired flow rate of gas to the patient. Real time feedback from the Flow Sensor through the Control System provides flow correction in the Flow Control Valve. The Flow Control System consists of a Proportional Voltage Servo Valve controlled by the real time measurement (2 ms) of flow through a variable orifice Flow Sensor. The variable orifice effect is created by a thin circular shaped piece of stainless steel that is mounted from an extended side in the flow stream. The flow will bend the metal creating a variable orifice. The flow proportional pressure drop is characterized and used for flow measurement. The Servo Control Electronics/Software receives and sends the control signals to the Flow Control System Components. Flow Control Valve adjustments are made for gas temperature, gas density, and backpressure.

Safety/Over Pressure System

The Safety/Pressure Relief Valve prevents over-pressure in the breathing circuit, and provides a connection between the patient and ambient air during a gas delivery failure from the Ventilator. A Check Valve downstream of the Safety/Pressure Relief Valve prevents flow from the patient back into the Ventilator. Pressure Relief around the Check Valve is accomplished through an orifice installed in parallel to the Check Valve. The Safety/Relief Valve allows the patient to breathe room air in the event of a ventilator or power failure. It also acts as an independent relief valve, which limits the maximum pressure the ventilator can deliver.

Hour Meter

The Hour Meter provides a means of monitoring the number of hours the ventilator is in use. In addition, it is used by the ventilator to track compressor hours of operation. A Curtis 201-hour meter is used. The hour meter is active as long as 5 volts is available. The hour meter outputs a continuous stream of serial data. The control processor reads the data by synchronizing to the start pulse of the data stream and then reading each successive bit. The hour meter does not have a visible readout and therefore must be read by software. The hour meter is hard mounted to the pneumatics engine and is cabled to the TCA PCB.

Heated Expiratory System

The heated expiratory system consists of a heated filter contained in a chamber with a micro-controller controlled heater, a water collector, an exhalation flow sensor, and a servo-controlled exhalation valve. The expiratory system is located at the end of the patient circuit; the Exhalation Valve regulates gas flow out of the patient circuit. Diaphragm position of the voice coil type active Exhalation Valve controls the exiting gas flow rate and patient circuit pressure with precision. Pressure feedback data is sent to the Electronic Control Unit continuously, which interprets the data, and based upon current ventilator settings, signals back to position the Exhalation Valve Diaphragm. Since the ventilator will be used in neonate, pediatric and adult ranges, the exhalation servo can be optimized for each circuit type to be used. The Water Collector and Filter remove contaminates from the gas flow before they reach the Flow Sensor, Exhalation Valve, or the environment. Also, warm air exhausts through the Exhalation System enclosure to the atmosphere.

The expiratory flow sensor determines flow by measuring the pressure difference across a variable orifice. The variable orifice is created with a thin circular shaped piece of stainless steel that is mounted on a hinge in the flow stream from an extended side. As flow increases and decreases the hinged flap creates the variable orifice effect. The pressure drop across the orifice is measured by a pressure transducer on the TCA and converted to flow by the software in the control micro-controller.

As stated earlier, the exhalation valve is a voice coil with a diaphragm. The exhalation valve controls circuit pressure, permits only one-way flow, and provides pressure relief above a set level during inspiration. The exhalation valve is controlled with a closed loop servo contained in the control micro-controller and is updated every 2 msec.

The water collector stores water that condenses in the expiratory limb of the patient circuit protecting the filter and exhalation valve system. The water collector consists of a vial and an inlet and outlet shaped fitting. A male 22 mm outside taper (15mm inside taper) connector is provided for the patient circuit connection and a 22 mm female connector is used for the heated filter.

The bacteria filter removes particles from the gas that exceed 0.3μm in size. The excess water drains into the water collector reducing the risk of contamination of the exhalation valve system. Warm heated air flows past the outside surface of the filter reducing condensation in the filter. The filter is an off-the-shelf purchased part.

Fan

A 40 cfm fan runs at all times to keep the internal temperature of the pneumatics module as close to ambient as possible. In addition, the fan forces flow out past the expiratory filter. A heater heats the gas as it exits in order to heat the filter as described above.

Compressor System (Optional)

The Compressor System provides 3 to 9.5 PSIG air pressure to the system when wall air is not available. The Compressor has two opposing machined aluminum involutes that are called Scrolls. One scroll orbits a fixed scroll forming air pockets that get progressively smaller as they travel from the outer to inner regions of the involute, compressing the gas. The shaft rotation from a brushless DC motor powers the orbiting scroll within the fixed scroll through an eccentric shaft. It operates at 800 to 3,000 RPM using about 100 watts at 24 VDC. A Pressure Servo improves power efficiency and noise by matching ventilator demand with supplied compressed air. While the accumulator is the device which handles the peak flow demand, the servo operates the compressor at a level which matches the minute ventilation of the patient.

Nebulizer System

The Nebulizer system provides a 10 PSIG source of blended gas for an external nebulizer. The gas will only be delivered during the inspiratory cycle of a breath so that the delivery of nebulized gas will be synchronized with the patient's breathing. Most manufacturers' nebulizers draw between 4 and 8 L/MIN at 10 PSIG.

Enhanced Patient Monitoring PCB (Optional-EPM) – Future Software Option

The Enhanced Patient Monitoring PCB provides Esophageal and Tracheal pressure monitoring and VARFLEX® wye flow sensing. The EPM PCB contains all of the signal condition as well as the pressure transducers for the esophageal pressure, tracheal pressure, and wye flow sensing. In addition, it contains a 12-bit serial ADC to convert the pressures to digital data. The TCA provides the chip select and solenoid control signals. Three solenoids are used to control the evacuation and filling of the Esophageal Balloon. Two solenoids are used to provide purge flow and auto zeroing of the flow sensor pressure transducer.

Chapter 3 Installation Instructions

This chapter provides instructions for installing the AVEA ventilator systems.

Stand Assembly

Basic Stand Assembly Instructions (P/N 15986)

Basic stand carton contents

QUANTITY	DESCRIPTION
10 each	5/16” screws
10 each	5/16 “ lock washers
2 each	1/2” nuts
1 each	Drag chain and modified washer
2 each	Flat washers for pole

Tools required

1/2“ open end socket

3/16” Allen wrench or driver

1. Remove the contents of carton.
2. Attach the base to the pedestal using the 5/16” screws, washers and nuts as shown in Figure 3.1. The anti-static drag chain may be attached to either screw.
3. Attach the pole to the assembly using the 5/16” screws and washers (refer to Figure 3.1).
4. Attach the top plate to the pedestal using the 5/16” screws and washers (refer to Figure 3.1).

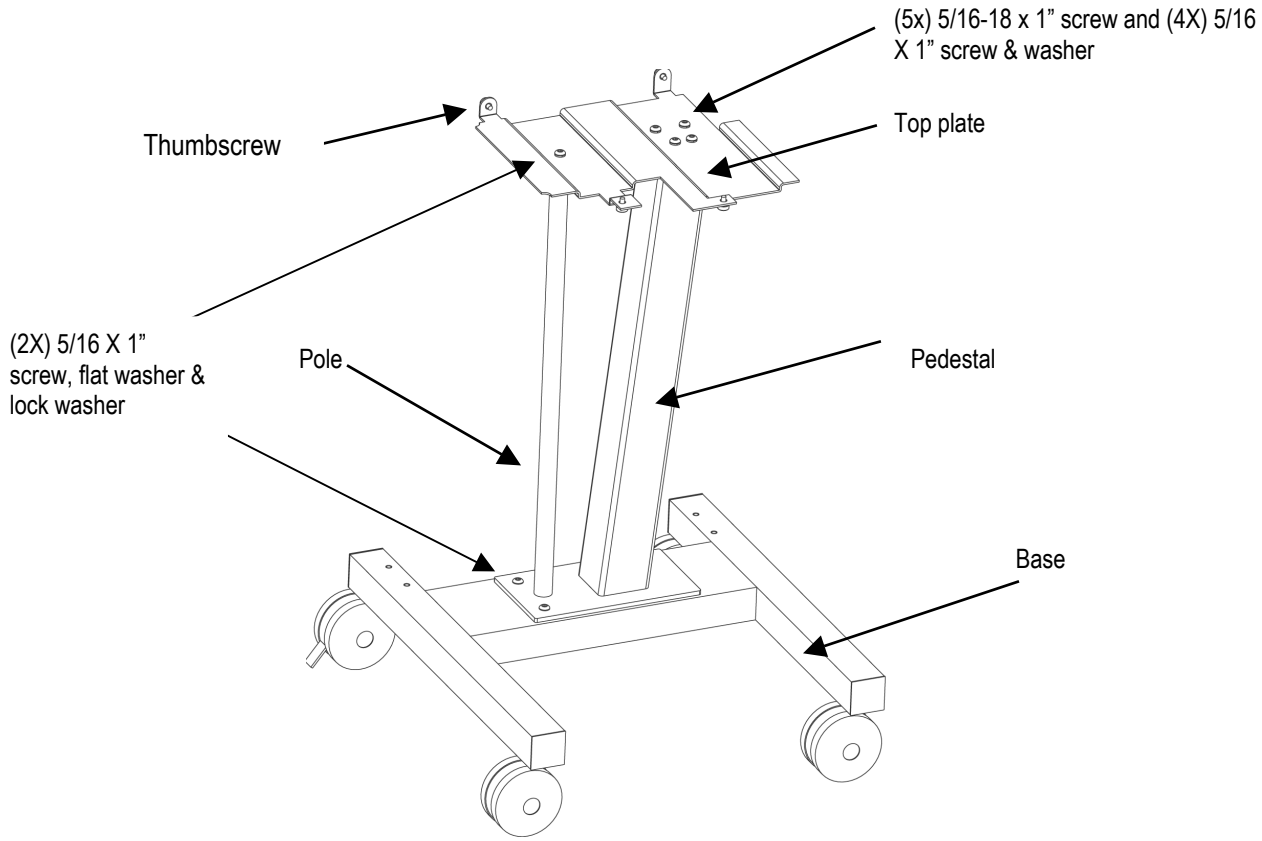

(5x) 5/16-18 x 1" screw and (4X) 5/16 X 1" screw & washer
Thumbscrew
Top plate
(2X) 5/16 X 1" screw, flat washer & lock washer
Pole
Pedestal
Base

Figure 3.1 Assembling the Stand

5. Place AVEA Ventilator on top plate, align thumbscrews (4) and lightly start all thumbscrews to locate AVEA Ventilator (refer to figure 3.2). Fully tighten (4) thumbscrews to secure AVEA Ventilator.

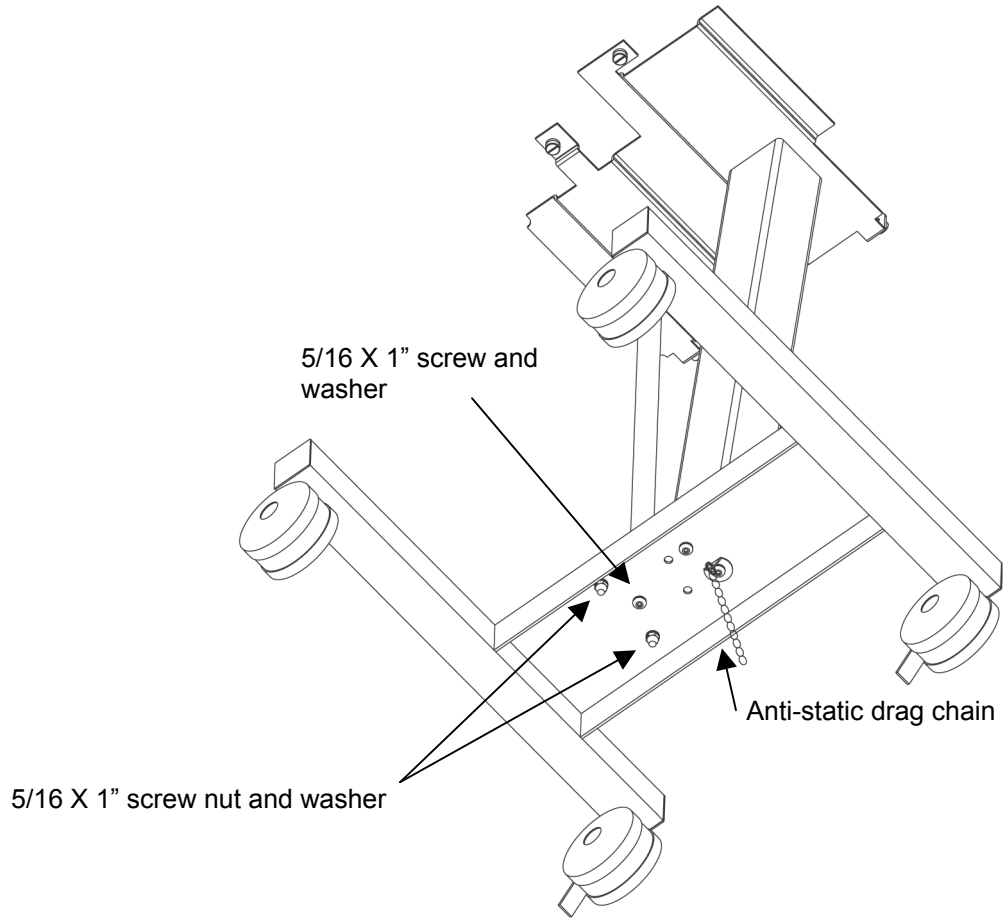


Figure 3.2: Bottom of stand

Comprehensive Stand Assembly Instructions (P/N 33976)

1. Open the main carton and remove and open the center carton that contains the pedestal, hardware and instructions.
2. Remove the second carton that contains top plate/pole and set aside.
3. Remove the four-legged base assembly from the carton and set the base on the floor as shown in Figure 3.1.
4. Place the pedestal onto the base assembly as show in Figure 3.1.
5. Using the 1/8” Allen wrench provided, install and secure the (4) 10/24” x ¾” screws along with the (4) star washers.
6. Install the collar set screw using the 1/8” Allen wrench as shown in Figure 3.2.
7. Remove the pole from the top plate carton and install and secure the I” pole using the collar set screw as shown in Figure 3.2.
8. Remove the top plate and set it onto the pedestal and pole as shown in Figure 3.2.

9. Using the 3/32” Allen wrench provided install and secure the (4) counter sink screws as shown in Figure3.#3.
10. Using the 1/8” Allen wrench, secure the set screw of the upper collar into the 1” pole as shown in Figure 3.2.

NOTE

If installing external battery pack, proceed to the external battery installation procedures.

11. Place the AVEA ventilator on the top plate, align the (4) thumbscrews, and lightly start all thumbscrews to locate AVEA Ventilator.]
12. Fully tighten (4) thumbscrews to secure the AVEA Ventilator.

External Battery Installation Procedures (P/N 11316)

Before installation, verify that the following parts are in your external battery kit:

Description	Quantity	Part Number
12V lead acid battery	2	16179
Battery tray, screw (10/32 x 5/16) X2, washer #10 X 2 & nut 10/32 KEPS		33977
Wire harness	1	51000-40825
PC Board	1	16105
Cable ties (10) & mounts (5)		52000-00239
Literature	1	L2353
Rack Tank Cart Assembly	1	33978

If any parts are missing contact VIASYS AVEA Customer Service.

1. Unscrew the (4) thumbscrews securing the base to the ventilator body as shown.
2. Lift the ventilator body and UIM from the wheeled base.
3. Gently set the ventilator down on a secure flat surface.

Note

Do not rest the ventilator on the protruding patient breathing gas outlet. Resting the weight of the ventilator on this outlet may cause damage resulting in leaks at the site.

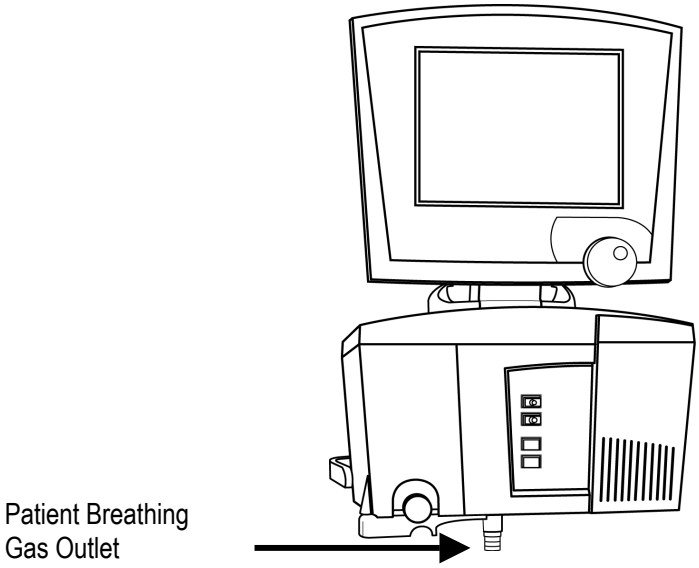


FIgure 3.3: Patient breathing gas outlet

4. If attached, remove the gas tank holder from the base.

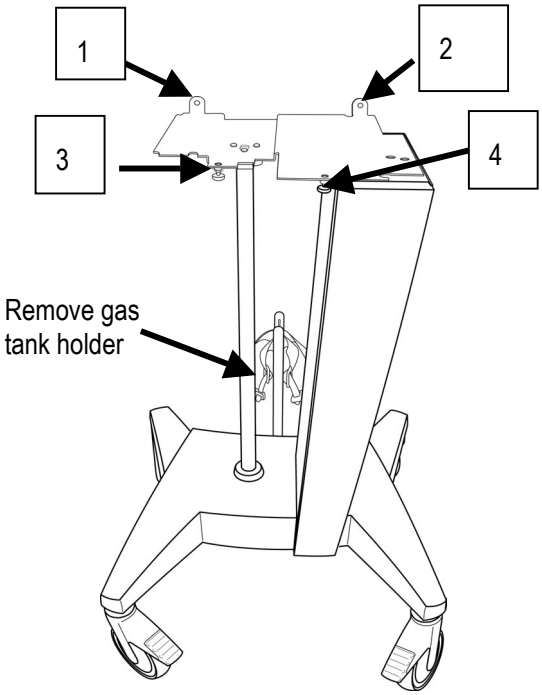


Figure 3.4: Remove gas tank holder

5. Detach the drop-cable portion from the main battery harness as shown.

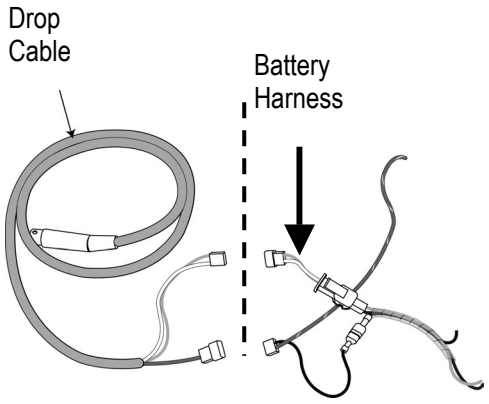


Figure 3.5: Drop cable and battery harness

6. Remove the two screws holding the face plate between the rear wheels of the AVEA cart and detach the faceplate.

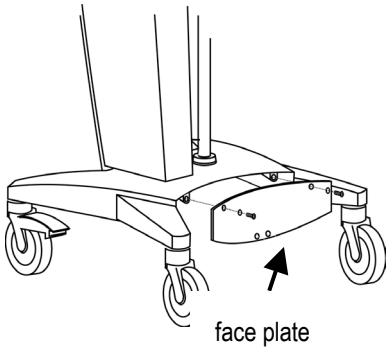


Figure 3.6: Face Plate

7. Thread the cable harness through the cart pole.

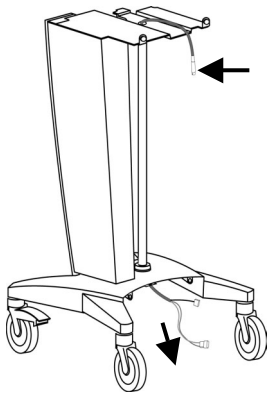


Figure 3.7: Threading the cable harness

CAUTION

After the cable has been threaded, inspect the cable for any cuts, abrasions or other damage.

8. Place the two batteries into the tray as shown in Figure 3.8.

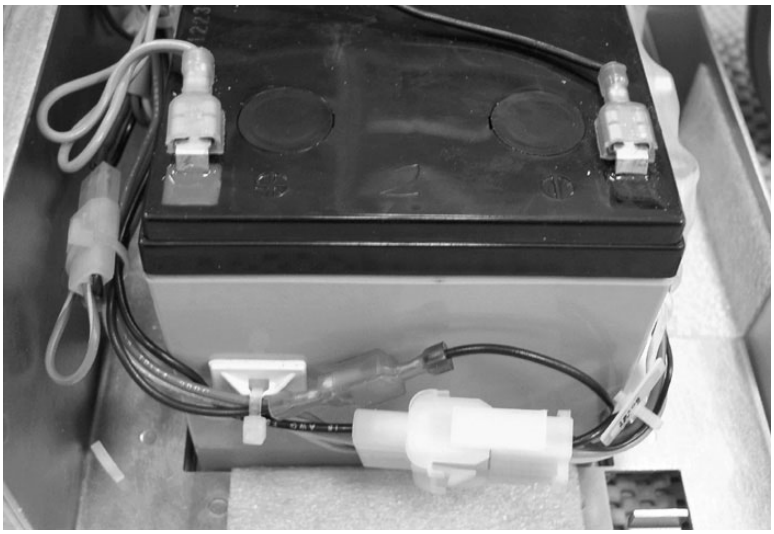


Figure 3.8: Placing batteries into the tray

9. Attach the harness (P/N 51000-40825) to the batteries:
   - Connect the black wire to the negative post (black) on the outer right battery.
   - Connect the dual orange wire to the positive post (red) on the inner right battery.
   - Feed the single orange and single red wires through the center battery support bracket opening to the left battery area.
   - Connect the single orange wire to the negative post (black) on the left battery.
   - Connect the single red wire (positive) to the positive post (red) on the left battery.

Figure 3.9: Battery harness

10. Attach the monitor PC board (P/N 16105) and wiring-- connect the 4-pin male molex to the 4-pin female molex from the battery harness

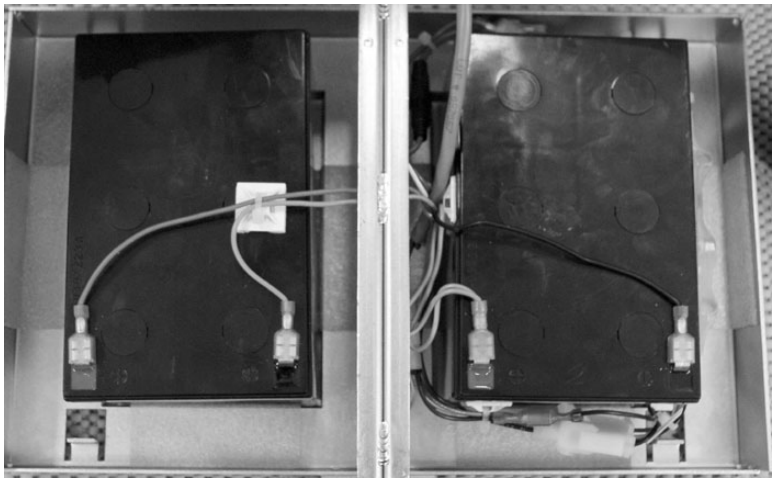


Figure 3.10

11. Connect the red wire harness (with fuse) to the 2 purple wires of the monitor PC board wiring.

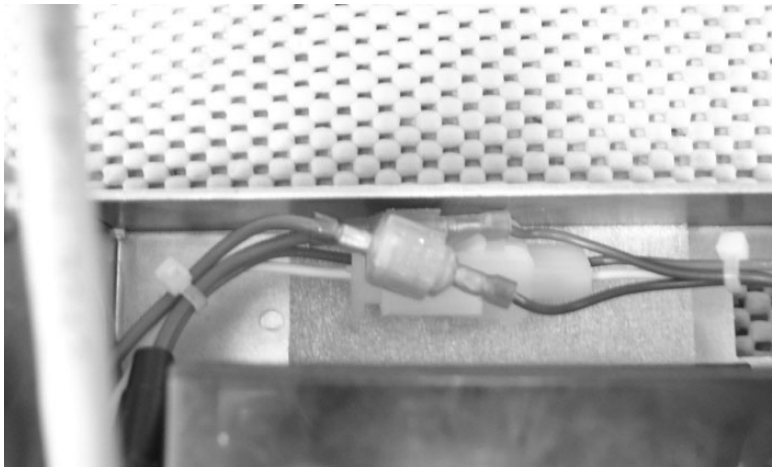


Figure 3.11

12. Attach the neutral ground wire harness: Connect the 2 pin male molex containing the single black and the single green/yellow ground wire to the drop cable 2 pin female molex containing the single black wire and the single insulated wire.

Figure 3.12

13. Attach the 2-pin molex male to the 2-pin molex female of the drop cable (red and white wires).

Figure 3.13

Final wiring connections and stabilization of external battery components

14. Attach the 2 pin male (red and white) connector to the 2 pin female (red and yellow) connector
15. Attach the black male connector of the drop cable to the black female connector of the 5 pin molex connector and monitor PC board
16. Attach the green and yellow ground wire lug connector to the grounding stud on the support bracket. Secure with the 10/32 KEPS nut provided
17. Use cable ties (P/N 52000-00239) and mounts to secure wires, harnesses, connections in such a way to prevent kinking, pinching, tearing, scuffing or any other damage while the external battery module is being assembled and mounted.

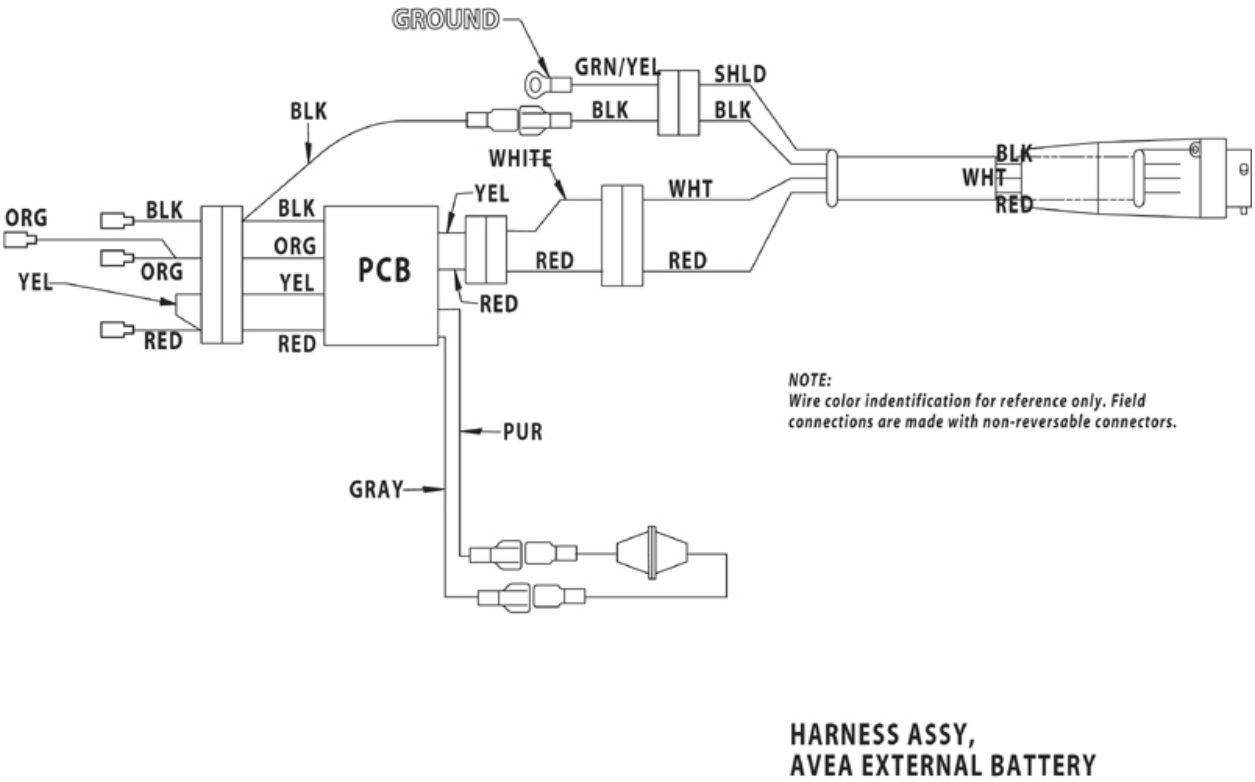


Figure 3.14

18. Slowly slide the completed battery and tray assembly onto the mount beneath the AVEA stand making sure that no wires are kinked or scuffed during assembly. Maintain tension on drop cable from top of cart to prevent kinking at battery tray. Sufficient cable slack must be available at top of cart to make connection at back of ventilator.

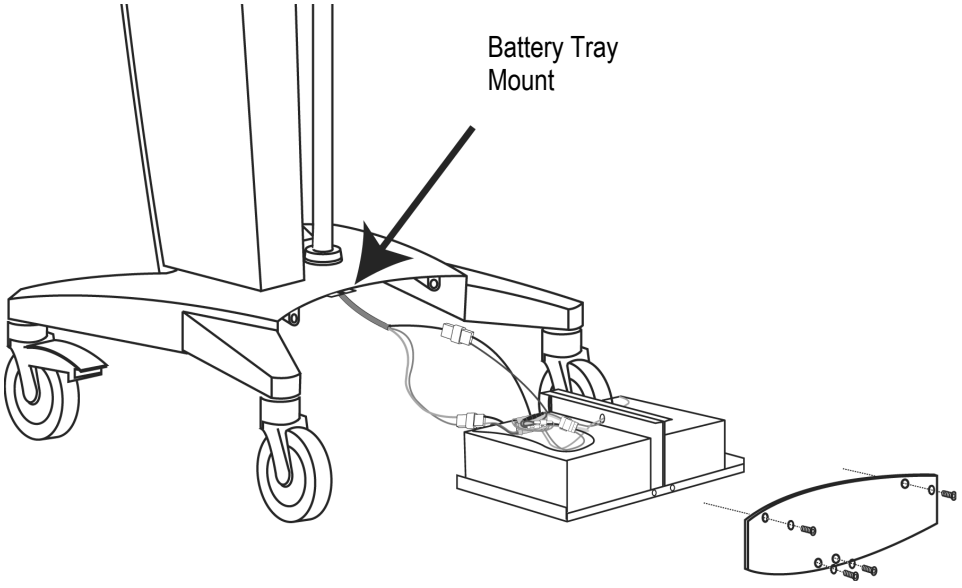


Figure 3.15

19. Attach the faceplate removed on in the instructions on page to the bottom of the battery tray with the hardware supplied.
20. Re-attach the ventilator body to the stand making sure the external battery cable lays untwisted in the cable slot and emerges at the rear of the ventilator.

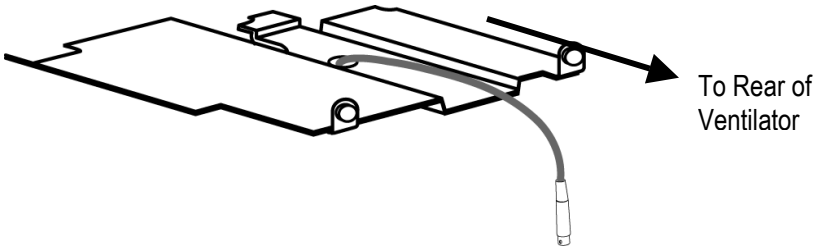


Figure 3.16

21. Connect the external battery cable to the connection labeled EXT BATT on the rear panel of the AVEA.

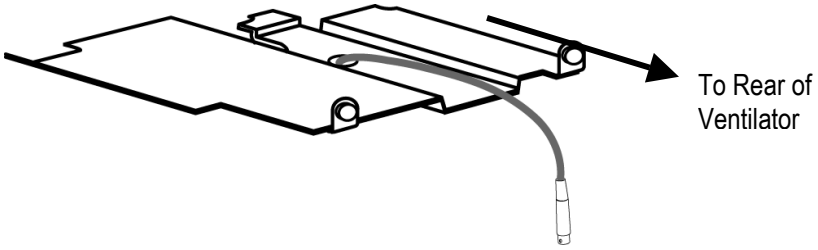


Figure 3.17

22. Plug the AVEA into a grounded AC outlet and apply power to the ventilator.
23. Check that the battery status display on the front panel indicates that the ventilator is connected to External battery power.

Note

The battery status will indicate red immediately after the external batteries are connected and the unit is powered up. If the batteries are fully charged, the battery status should indicate green (charged) within one hour of connection. If the batteries are not fully charged, it may take several hours to indicate green. Refer to your operator's manual for recommended battery charging.

"E" Cylinder Bracket Assembly Instructions

Before installation, verify that the following parts are in your external battery kit:

Quantity	Description
1 each	Saddle
1 each	Center post with Velcro cylinder straps
2 each	1/4"-20 counter-sink allen-head screws
4 each	1/4"-20 round-head allen screws
4 each	Lock washers

Tools Required for Assembly

1 each 5/32" allen wrench/driver

Assembly Instructions for Basic Stand Bracket

1. Install the center post in the tank bracket using two flathead 1/4"-20 thread screws to secure. (Figure 3.18)

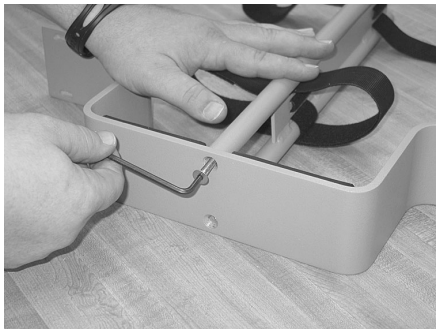


Figure 3.18

2. Place assembled tank bracket on short side of “H” stand legs. (Figure 3.19)

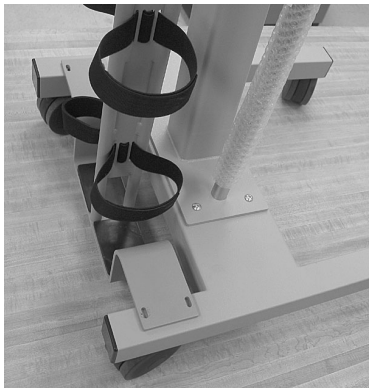


Figure 3.19

NOTE

If there are pre-drilled holes on the “H” stand, skip to Step 8.

3. Place tape measure under bracket. Slide bracket back 3/4” from the edge of the “H” cross piece. (Figure 3.20)

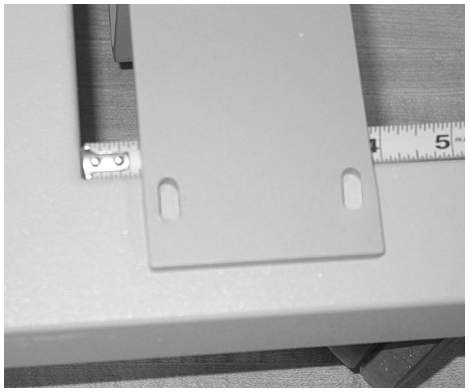


Figure 3.20

4. Center the bracket on the two legs of the “H”. The bracket should be positioned approximately 11/16” from the outside edge of each leg. Recheck the initial 3/4” dimension measurement (refer to Figure 3.21).

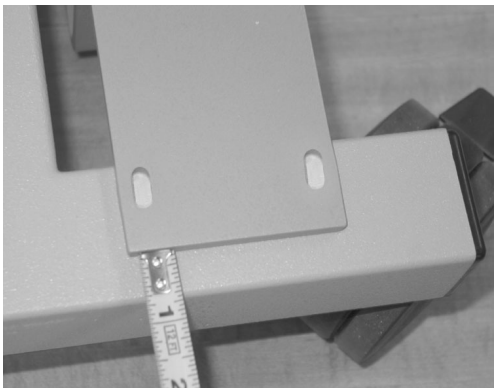


Figure 3.21

5. Using a pencil, mark location of tank bracket in center of slotted holes on the bracket. (Figure 3.22).

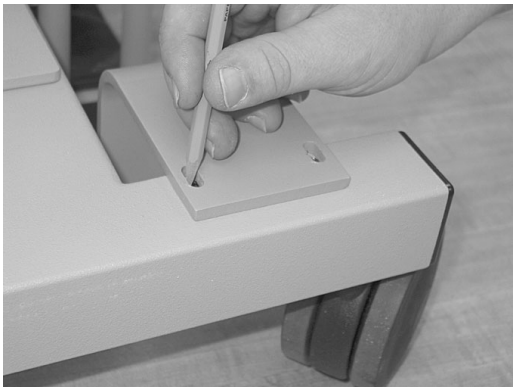


Figure 3.22

6. Center punch-marked locations. Before drilling, move rear wheels out of the way to prevent damage. (Figure 3.23).

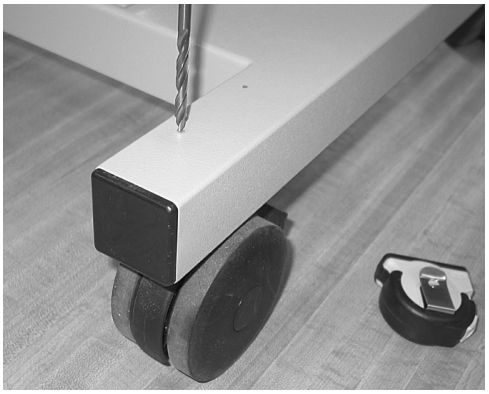


Figure 3.23

7. Using 17/64" (.265) drill bit, drill through both bracket walls. (Figure 3.24)

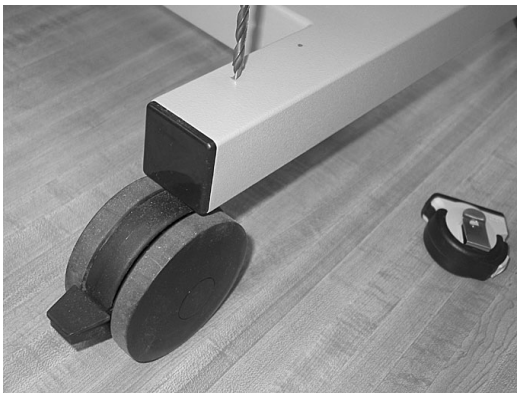


Figure 3.24

8. Remove burrs from drilled holes and insert screw from bottom, guiding through both holes in tubing and tank bracket. (Figure 3.25)

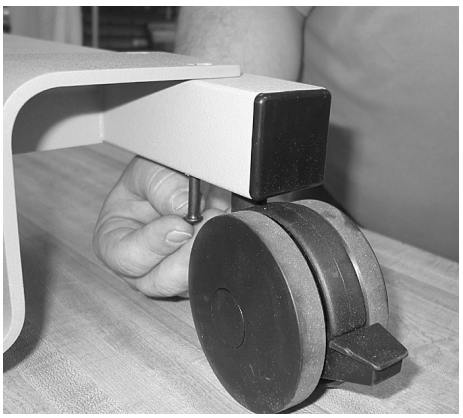


Figure 3.25

9. Place washer (x4) and nuts (x4) over screws and tighten securely.

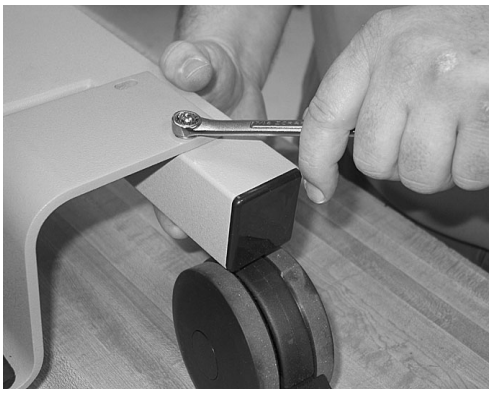


Figure 3.26

Assembly Instructions for Comprehensive Stand Bracket

1. Place the comprehensive stand on a flat surface with the rear of the stand facing up.
2. Align the saddle with the 4 stand mounting holes.
3. With the 5/32 allen wrench, install and secure the 4 screws and lock washers to attach the saddle to the stand.

CAUTION

Ensure that the saddle is in no way touching the wheels/casters of the stand.

AVEA Unpacking Instructions

Introduction

The AVEA is packaged in two parts for safe shipping. A small amount of assembly is required. All literature and instructions to enable you to safely assemble, set up and check your AVEA are included in the box with your ventilator.

Unpacking

CAUTION

The AVEA shipping container is designed to be moved or positioned by a forklift or pallet jack only. **Do not attempt to lift or manipulate the container manually as damage or injury could result.**

Note

The AVEA Cart shipped with your ventilator must be assembled first. To reduce the risk of damaging the ventilator, make sure the cart is ready before you unpack the instrument.

Note

Your Operator's Manual and other important literature are packed beneath the AVEA. ***Do not discard!***

1. Remove all outer securing straps by cutting them. Discard.
2. Open the box and remove the top layer of packaging material. (Figure 3.27)

Figure 3.27

3. Remove the AVEA accessory box. Place it on a secure surface. (Figure 3.28)

Figure 3.28

4. To remove the cardboard cover, lift the box straight up. Do not pull or tilt the cover until you are sure it has cleared the ventilator.
5. Remove the protective packaging from the sides of the ventilator and carefully remove the plastic. (Fig. 3.29)

Figure 3.29

6. Apply the brakes on the cart that has been previously assembled by pressing down on the foot pedals. (Fig. 3.30)

Figure 3.30

7. With assistance, lift the AVEA from the box and carefully position the unit on the top plate assembly of the cart. Secure the unit using the 4 thumbscrews. (Figure 3.31 and Figure 3.32)

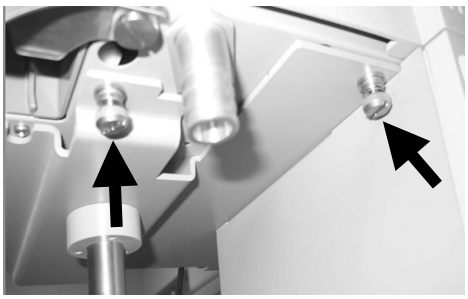


Figure 3.31

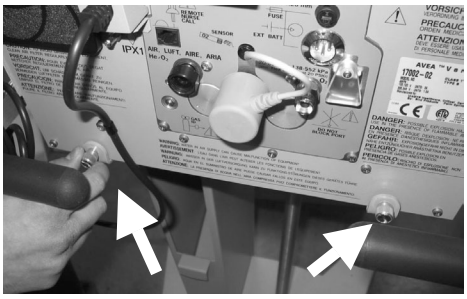


Figure 3.32

Note

Make sure the external battery cable lays untwisted in the cable slot and emerges at the rear of the ventilator (if applicable)

8. Loosely secure the 2 thumbscrews in the back of the ventilator, followed by the 2 thumbscrews on the bottom front of the unit. Tighten all 4 screws.

Medical Gas Connector Kit Installation Instructions

Air "Smart" Connector Installation Instructions (P/N 51000-40897)

Note

If you have not ordered the Heliox option, you will receive only the Air smart connector and the appropriate air hose for your configuration. The Air connector comes pre-assembled with the integral water trap/filter as shown in figure 1. It attaches to the fitting located to the left of the Oxygen cell on the rear panel of the AVEA.

CAUTION
Always consult your Operators Manual for instructions and clinical recommendations concerning the use of AVEA accessories.

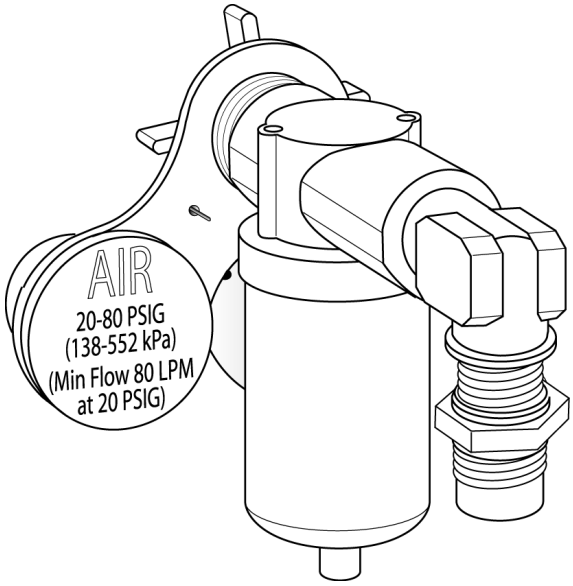


Figure 3.33

1. Carefully align and seat the ‘smart’ connector pin and the gas fitting.

2. Tighten the threaded collar on the AVEA onto the male gas fitting of the “smart’ connector assembly. (Fig. 3.34)

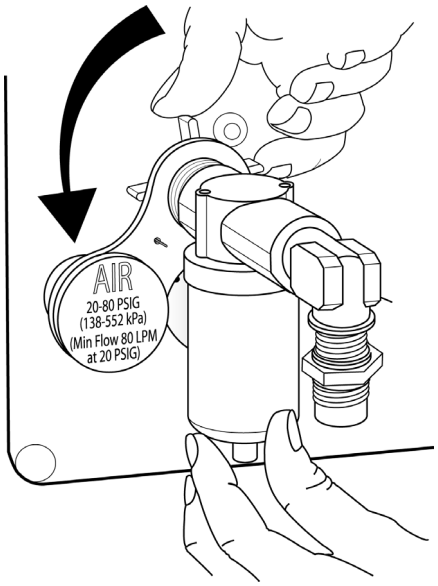


Figure 3.34

3. Attach the Air hose appropriate for your gas configuration. (Fig. 3.35) (Female DISS fitting is shown here).

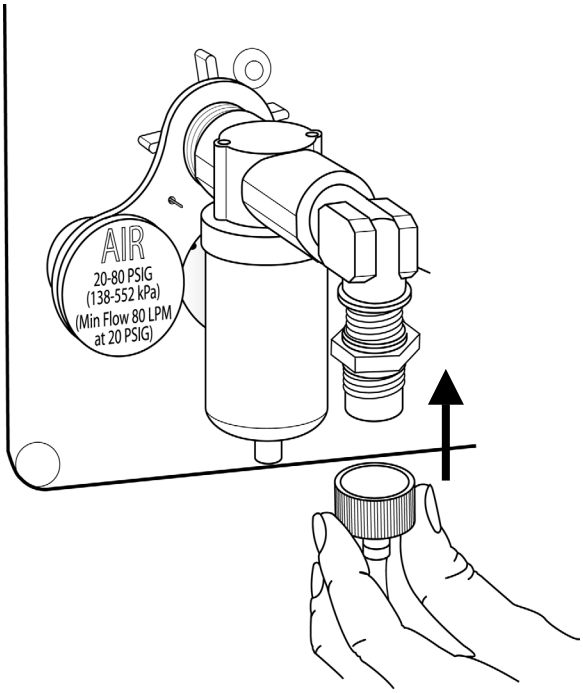


Figure 3.35

Air and Heliox Tethered "Smart" Connector Installation Instructions (P/N 16132)

WARNING

Connection of a gas supply at the Helium-Oxygen mixture inlet that does not contain 20% oxygen can cause hypoxia or death.

Although an 80/20 mixture of Helium and Oxygen is marketed as medical grade gas, the Helium/Oxygen gas mixture is not labeled for any specific medical use.

Note

The Heliox "smart" connector comes already tethered to the Air assembly and the "smart" connector attachment bracket as shown in figure 4.

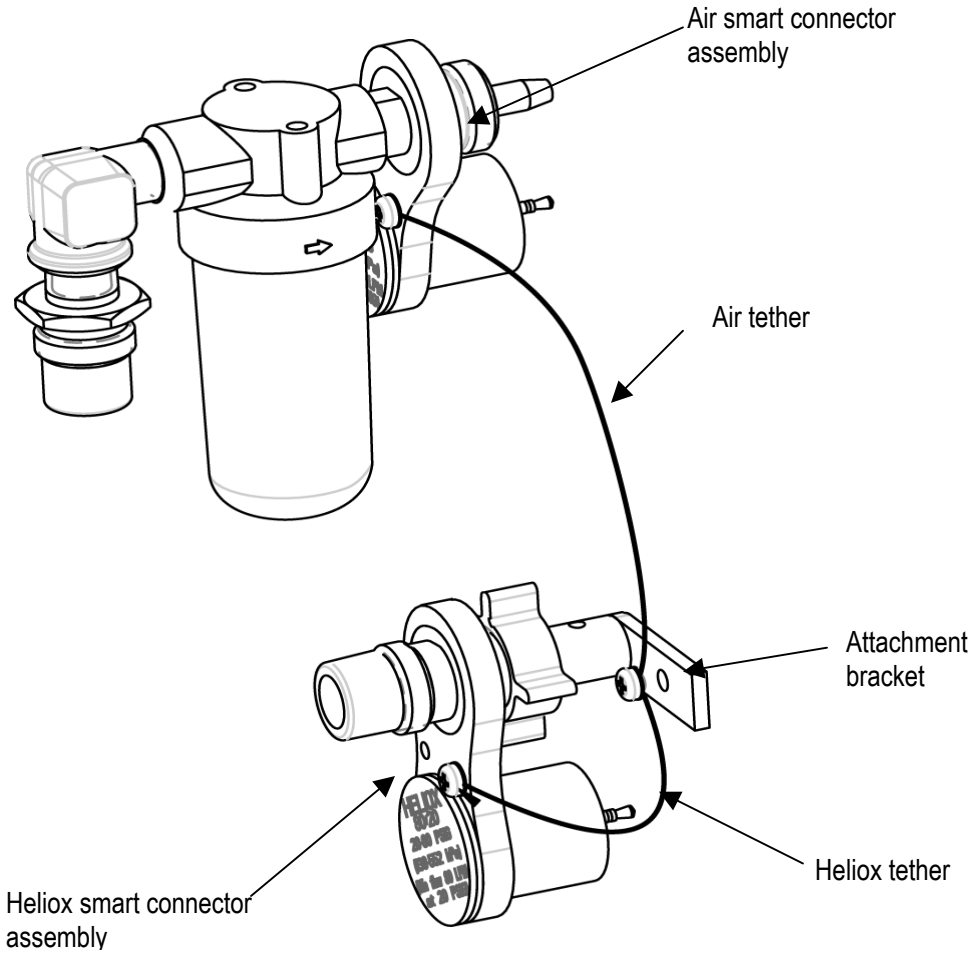


Figure 3.36

Note

The Heliox "smart" connector is designed for use with an 80/20 Heliox tank only. Only a mixture of 20% oxygen and 80% Helium can be used as the Heliox gas supply.

1. To assemble the Air/Heliox assembly, first attach the Air "smart" connector/water trap assembly to the AVEA rear panel fitting as described in the "Air connector only installation instructions" section.
2. After attaching the Air connector, remove the Philips screw from the rear of the AVEA. (Figure 3.37)

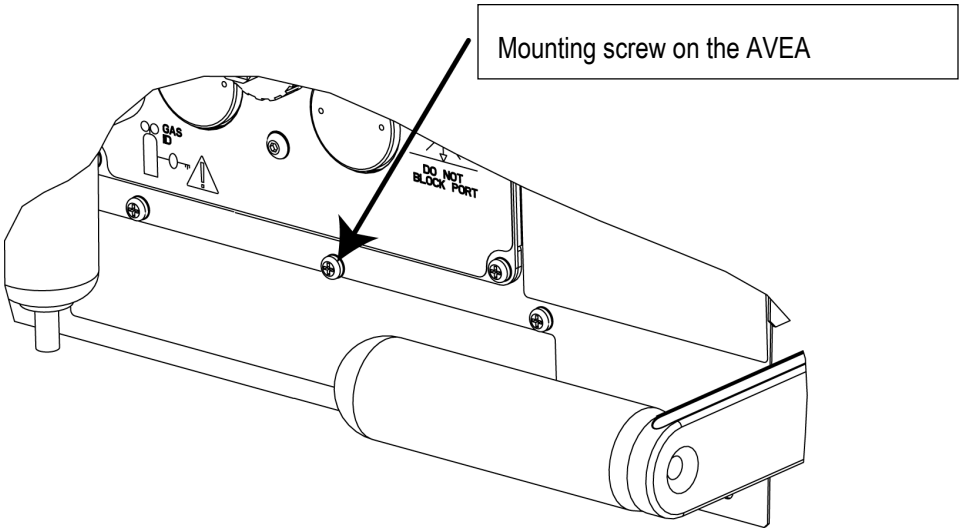


Figure 3.37

3. Insert the screw provided in the kit through the mount on the tethered Heliox Smart connector holder. (Fig. 6)

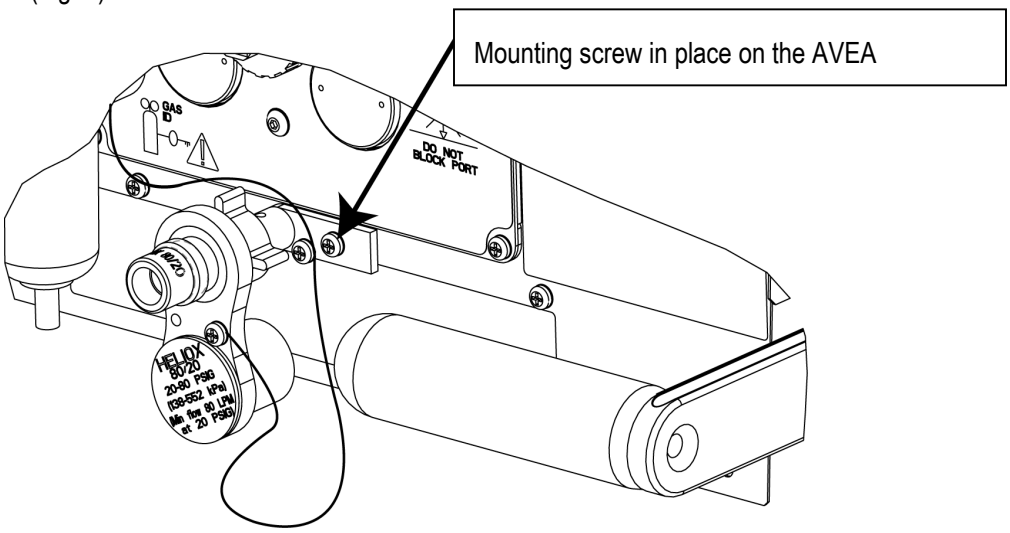


Figure 3.38

Heliox "Smart" Connector Installation Instructions (P/N 51000-40918)

Note

The Heliox "smart" connector is designed for use with an 80/20 Heliox tank only. Only a mixture of 20% oxygen and 80% Helium can be used as the Heliox gas supply. To use the Heliox "smart" connector you must turn off the air gas supply and unscrew and detach the Air hose from the air smart connector.

CAUTION

The air "smart" connector and water trap are removed as one unit. Do not attempt to separate them as you may damage the assembly.

Note

Heliox 15' hose is P/N 50000-40042.

1. To remove the Air "smart connector and water trap, support the assembly with one hand and loosen the attachment collar. (Figure 3.39)

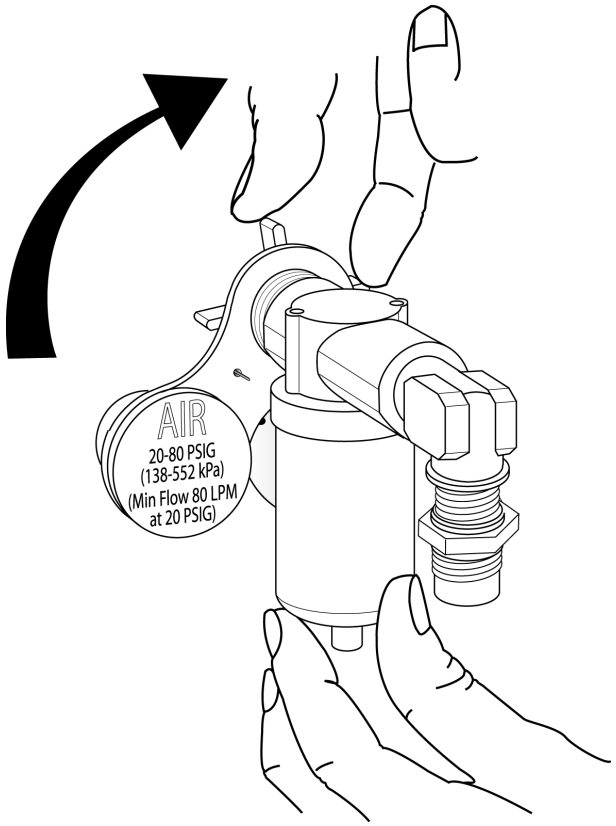


Figure 3.39

2. While still supporting the air connector, loosen the collar of the tethered Heliox Connector and detach it from its storage bracket. (Figure 3.40)

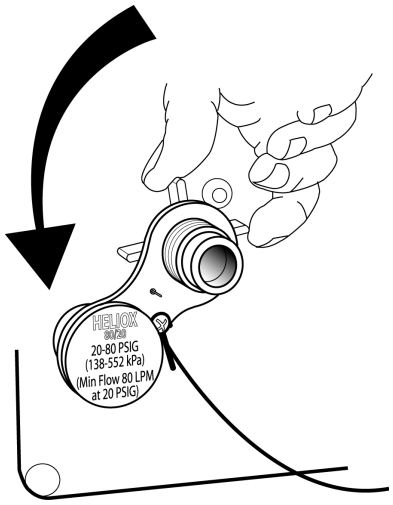


Figure 3.40

3. Position the Air connector onto the same support bracket and tighten down the collar until the air connecter and water trap are **fully secured** to the storage bracket.

CAUTION

Make sure that neither the air nor the Heliox tether gets caught in the support collar while you are tightening it down. If either tether fouls the threads of the collar, the Air connector assembly may not be adequately secured to the bracket.

4. Align the Heliox smart connector with the Smart connector receptacle on the left side of the AVEA back panel from which you removed the Air connector. Tighten down the collar of the gas port onto the Heliox fitting. (Figure 3.41)

5. The HeO2 cylinder symbol should appear in the lower right hand corner of the user interface screen.

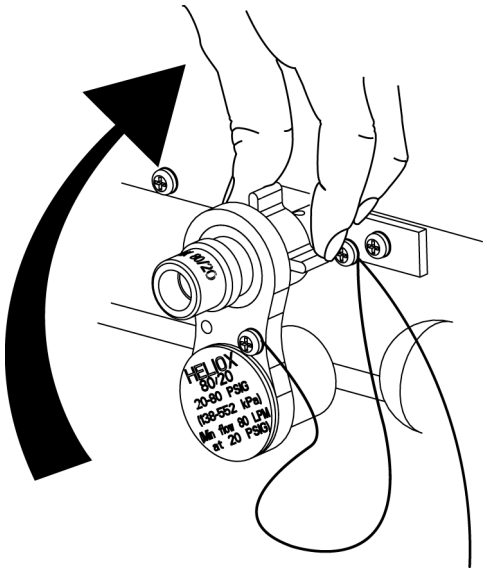


Figure 3.41

Chapter 4 Assembly and Disassembly

General Instructions and Warnings

The removal and installation of major subassemblies requires OVP and possibly calibration. Refer to chapters 5 and 7 for instructions.

When disassembling or assembling the AVEA, refer to the tubing diagram, P/N 51000-40840, the wiring diagram P/N 51000-40839 and appropriate schematics and assembly drawings located in Appendix B of this manual. The illustrations shown here are for reference only, current revisions of these diagrams and schematics are available to qualified personnel from VIASYS Healthcare, Critical Care Division, Technical Support.

WARNING

Always take standard ESD precautions when working on AVEA ventilator systems.

Assume that you are adequately earth grounded prior to handling and working inside of the AVEA ventilator.

Ensure the ventilator is disconnected from the AC power supply before performing repairs or maintenance. When you remove any of the ventilator covers or panels, disconnect the internal battery "quick release" connector (see figure 3.1) before working on the ventilator. If the ventilator has an external battery installed, ensure that the external battery is unplugged from the rear panel before proceeding.

Recommended Tools & Equipment

Note

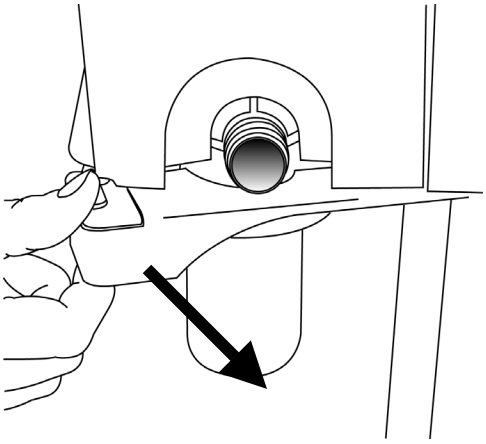
Before using any test equipment [electronic or pneumatic] for calibration procedures, the accuracy of the instruments must be verified by a testing laboratory. The laboratory master test instruments must be traceable to the NIST (National Institute of Standards Technology) or equivalent. When variances exist between the indicated and actual values, the calibration curves [provided for each instrument by the testing laboratory] must be used to establish the actual correct values. This certification procedure should be performed at least once every six months. More frequent certification may be required based on usage.

Long & short Philips screwdrivers	
Flat bladed screwdriver	
7/8" Nut Driver	
11/32" Nut Driver	
Digital Volt Meter	
Adult test Lung	P/N 33754
Adult Patient Circuit	P/N 16045
Infant test lung	P/N 10107
Infant Patient Circuit	P/N 16044
Oxygen Analyzer	
Rubber Stopper	
Stop Watch	

User Interface Module (UIM) and Top Cover

UIM Removal

1. If installed, remove the exhalation filter assembly as shown below.



Rotate the metal locking lever on the lower right of the ventilator body forward to an open position.

Figure 4.1 Open locking lever

Remove the exhalation filter assembly from the ventilator body as shown. Pull straight down.

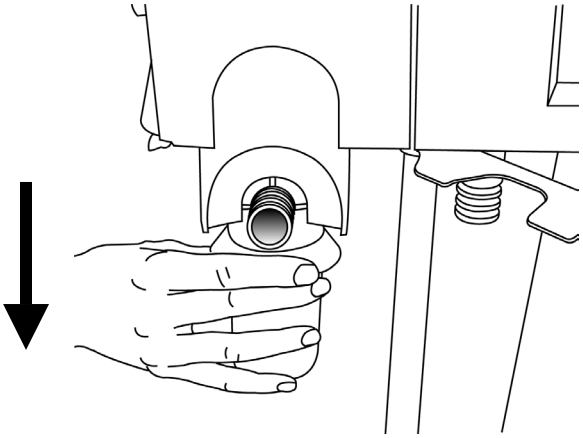
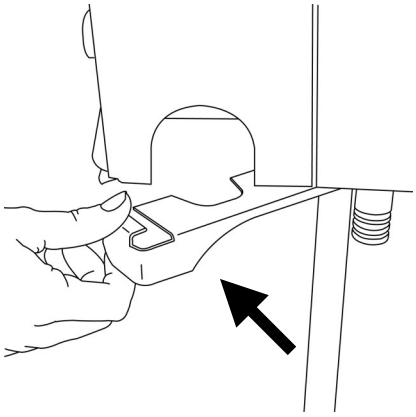


Figure 4.2 Remove exhalation filter



Close the locking lever.

Figure 4.3 Close locking lever in place

2. Remove the rubber collar by grasping one of the two rubber tabs at the bottom. Pull firmly in an "arcing" motion.
3. Remove the (1) Phillips screw on the front arm cover below the monitor and remove the front arm cover.
4. Remove the two mounting screws now visible inside the back arm cover.
5. Tilt down the UIM screen and remove the back arm cover.
6. Remove the (2) Phillips screws on the connector attached to the rear panel and unplug the UIM interface cable.
7. Using a long Phillips screwdriver, remove the (1) Phillips screw located at the top of the exhalation filter assembly well. It is suggested to temporarily disconnect the flow sensor in able to obtain easier access to this area.

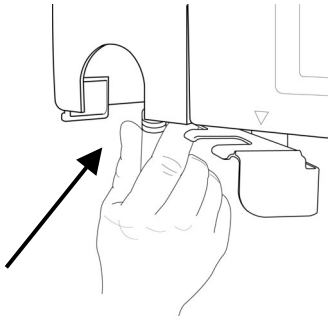


Figure 4.4: Screw Removal

8. Remove the (1) Phillips screw located at the exhalation port marked EXH.

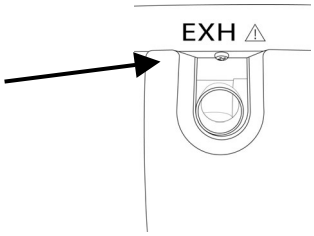


Figure 4.5: EXH Screw Removal

9. Remove the (4) 11/32 KEP nuts on the rounded portion of the molded plastic top cover.
10. While supporting the UIM continuously, remove (4) 3/8 KEP nuts holding the UIM in place on the aluminum ring.
11 Remove the UIM, then the plastic top cover.
12 Remove (19) SEMS screws (3) on the left, (5) on the right and (11) on top.

WARNING

Always disconnect the white battery quick disconnect once the top cover is removed to prevent injury and/or damage to the AVEA Ventilator System.

Note

Prior to complete reassembly, UIM may be temporarily installed for testing and calibration.

Installation

1. Re-connect the internal battery.
2. Replace the top cover, ensuring that the left side is behind the plastic lip and the front is behind the plastic cover. Secure with (19) SEMS screws, (3) on the left side, (5) on the right side, (11) on the top.
3. Set the plastic cover on top of the unit.
4. While supporting the UIM, position the screen toward the front, feed the interface cable under the plastic cover towards the back panel, line up the mountings over the threaded studs, and secure the UIM with (4) KEPS nuts.
5. Install the lug caps on the (4) 3/8 KEPS nuts.
6. Install and secure the cable (molded gray cover connector) using Phillips screws with washers to the rear panel.
7. Install, but do not secure, the plastic cover with (4) 11/32 KEPS nuts.
5. Attach the Phillips screw located in the exhalation port.
9. Using a long Phillips screwdriver, attach the screw located above the exhalation filter assembly.
10. Reattach the exhalation filter assembly.
11. Tighten the (4) 11/32 KEPS nuts on the plastic cover.
12. Install the (2) Phillips screws on the back that attach the molded plastic cover to the unit.
13. Tilt the UIM down and install the back arm cover by pushing it into the rubber gasket at the top of the arm and snapping down the cover. Re-attach the two mounting screws.
14. Replace the front arm cover being sure to locate the two molded protrusions on the top of the front arm cover into the corresponding notches on the top of the back cover. Secure with the long Phillips screw.

Gas Delivery Engine P/N 51000-40022

Gas Delivery Engine Removal

1. Referring to the instructions in this chapter, remove the following components:
   - UIM and the molded and metal top covers
2. Remove the (4) SEMS screws located at each corner of the rear panel.
3. Disconnect the yellow hose from the white connector that goes to the accumulator; cut the tie wrap, pull off the metal tubing support (see diagram), Cut the tie wrap. Pull off the metal tubing support, and release from the compression fitting.
4. Completely remove the yellow hose between the gas delivery engine assembly and the white scroll pump/compressor filter.

5. Squeeze the two small ribbon cables near the front of the gas delivery engine assembly (the 0-pin ribbon cable connector from the flow sensor assembly and the 20-pin ribbon cable connector from the front interface panel).

CAUTION

Never pull on a cable during disconnection, damage to the connector wiring may result. Always pull on the connector body to disconnect.

6. Unscrew the luer-lock fittings (the clear tubing from F4, and the black striped tubing from G4)..

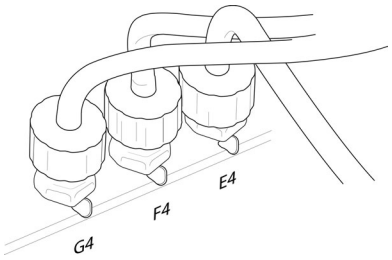


Figure 4.6 G4 and F4 luer connections

7. Disconnect the tubing to the bleed from yellow C4 by releasing the compression fitting.
8. Disconnect the large blue tubing to the nebulizer from H4 by releasing the compression fitting.

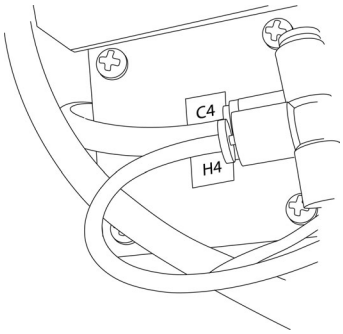


Figure 4.7 C4 and H4 compression fittings

9. Disconnect the yellow tubing (D4) that feeds the EPM board.
10. Disconnect the 4 pin connector from the battery monitor board to the gas delivery engine.
11. Loosen the 11/32 nut securing the assembly to the base at the bottom front left.
12. Ensure all cables and tubing are tucked into the gas delivery engine assembly and slide the assembly out of the unit towards the rear. You will here a distinct “pop” as the assembly disconnects from the driver transition board connection.

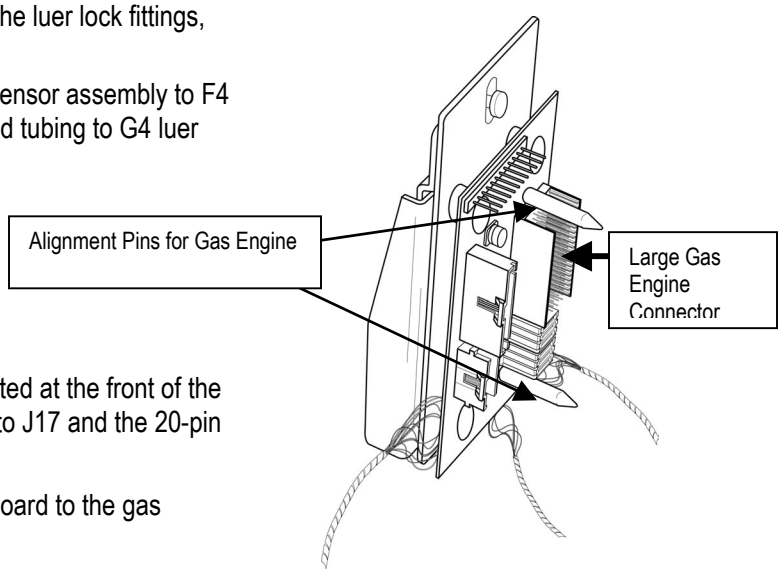
Note

You may need to pull firmly as you slide out the gas delivery engine assembly because it is attached to the 120-pin connector on the driver transition board.

Installation

WARNING
Prior to re-installing the GDE, Insure that C31 is not touching the Flow Control Valve or that there is insulation material between the two. (C31 is the orange capacitor located closest to the top of the FCV).

1. Ensure all cables and tubing are tucked into the gas delivery engine assembly and slide it as far into the unit as required to hold the assembly. Do not yet connect the assembly to the driver transition board.
2. Connect yellow hose (D4) to the EPM board.
3. Connect the tubing from the EPM board into C4 by inserting into the compression fitting.
4. Connect the yellow bleed tubing from the sensor assembly: the clear yellow tubing to F4, and the blue tubing to G4. To connect into the luer lock fittings, twist and push.
5. Connect the clear tubing from the sensor assembly to F4 luer lock fitting, and the black striped tubing to G4 luer lock fitting.



6. Connect the two ribbon cables located at the front of the ventilator (the 10-pin ribbon cable to J17 and the 20-pin ribbon cable to J16).
7. Connect the 4 pin battery monitor board to the gas delivery engine.
8. Engage the gas delivery engine to the driver transition board by ensuring proper alignment of the two alignment pins and the connector and pressing firmly into place.

Figure 4.8 Gas Engine Connector on Driver Transition PCB

CAUTION
It is essential to ensure correct alignment to the 120-pin connector on the driver transition board (see diagram) before pushing home the gas delivery engine. Failure to do so may result in damage to the connector and the unit may not power up or operate properly.

9. Attach and secure the (4) SEMS screws on the four corners of the rear panel.
10. Replace the yellow hose from the gas delivery engine to the compressor filter. Ensure that you position
11. Connect yellow hose from the accumulator into the compression fitting. Replace the metal safety bracket, and secure with a new tie wrap.
12. Tighten the 11/32 nut at bottom right of the Gas Delivery engine and tighten down.

13. Referring to the instructions in this chapter, install the following components:
    - UIM and the top cover.

Ventilator wheeled base

Removal

1. Unscrew the (4) thumbscrews on attaching the base to the ventilator body as shown in figure 3.16 and detach from the wheeled base.

Installation

1. Position the ventilator assembly onto the base by lining up the holes over the 4 spring-loaded thumbscrews and tighten the thumbscrews.

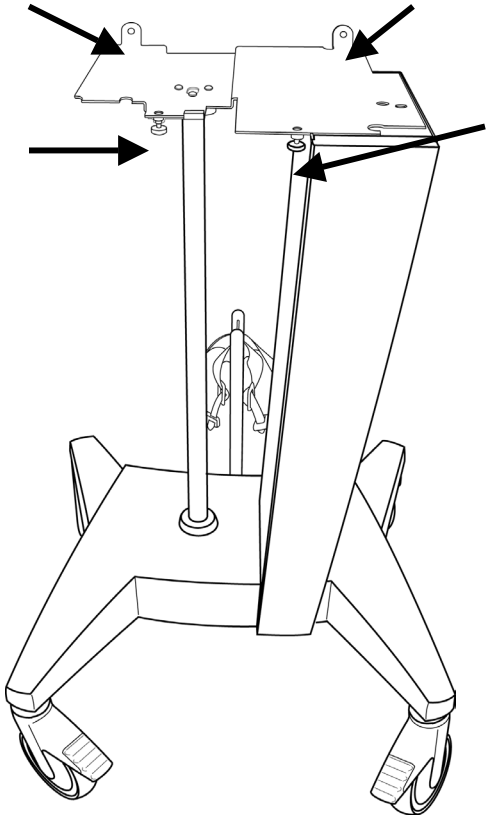


Figure 4.9 Wheeled base showing attachment points

Internal Batteries

Removal

1. Referring to the instructions in this chapter, remove the following components:
    - UIM and the top cover
    - Internal battery fuse holder
2. Disconnect the battery fuse holder by pulling straight back on the two faston connectors.
3. Remove the fuse holder and fuse from the ventilator chassis using pliers to remove nut.
4. Remove the (3) 11/32 KEPS nuts that hold the battery bracket in place; (2) KEPS nuts on the bottom and (1) on the top.
5. Slide out the retaining bracket and the batteries.

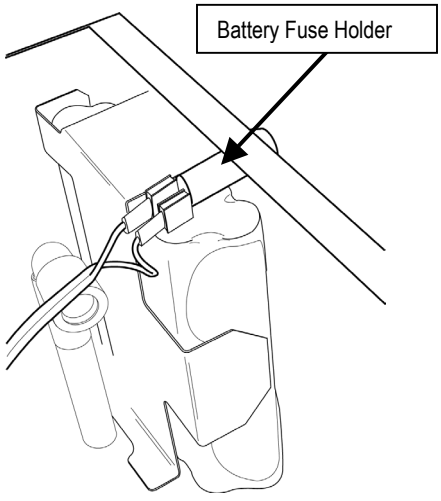


Figure 4.10 Battery fuse holder & Bracket

6. Disconnect the positive and negative leads from the wire harness that connects to the driver transition board.
7. Cut both tie wraps that secure the battery monitor board and the 4-pin molex to the batteries.
8. Disconnect the batteries from each other.

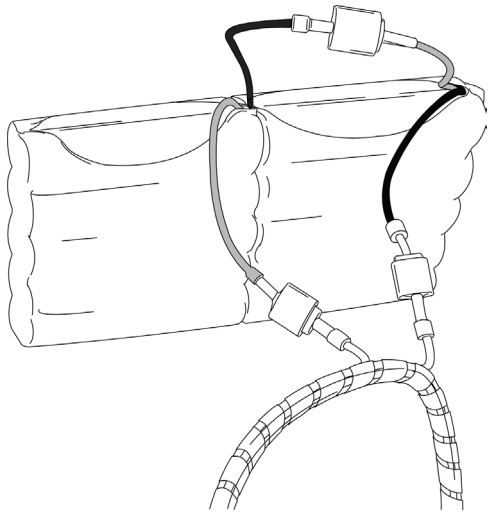


Figure 4.11 Battery Assembly

Installation

1. Cut three 3” stripes of 1” wide double-backed adhesive tape. Place one strip on the bottom of one battery, and the other two strips on the top and bottom of the other battery.
2. Place the first battery against the chassis and the second battery on top of the first.
3. Secure the batteries into place with the retaining bracket by using (3) 11/32 KEPS nuts; (2) KEPS nuts on the bottom and (1) on the top.
4. Connect the positive and negative battery leads to the wire harness that connects to the driver transition board. (These are arranged M-F and F-M so they cannot be wrongly connected)
5. Replace the fuse holder into the front of the chassis.
6. Connect the lug connectors to the two battery fuse terminals using either combination of wires.
7. Referring to the instructions in this chapter, install the following components:
   - UIM and the top cover.

Compressor/Scroll Pump P/N 51000-09750

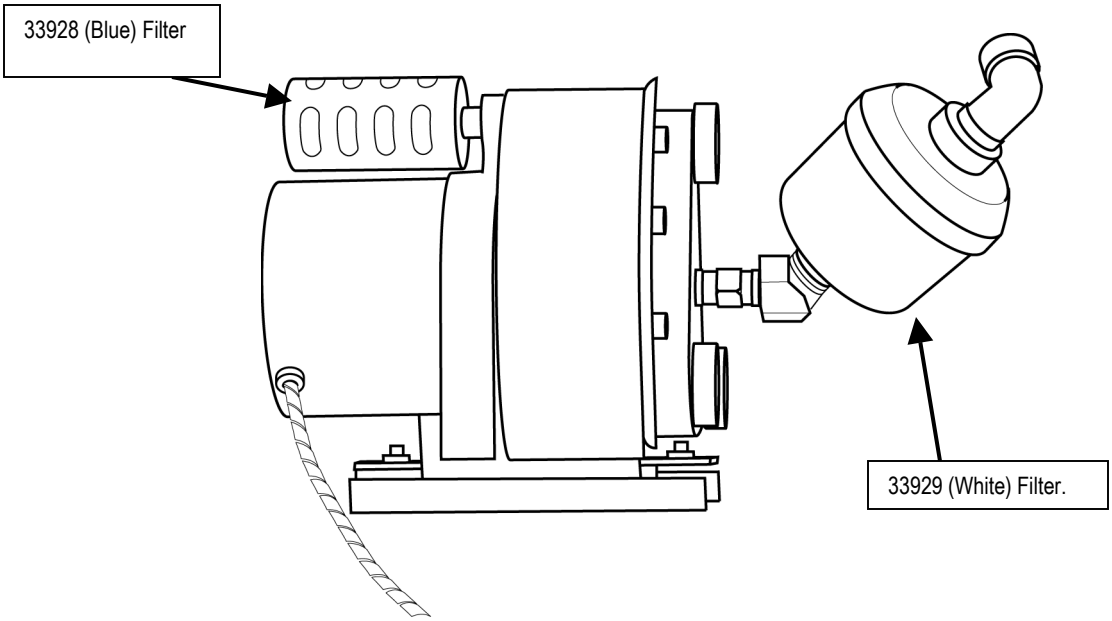


Figure 4.12 Compressor/ Scroll Pump

Removal

1. Referring to the instructions in this chapter, remove the following components:
   - UIM and the top cover.
2. Remove high pressure hose from compressor motor at the filter outlet. Move the high pressure hose out of your working area.
3. Remove the (4) 11/32 KEPS nuts in each corner of the compressor mounting base. Remove the (1) ground wire located at the front right of the compressor.
4. Disconnect compressor wiring harness (molex P2) from compressor driver board.
5. Carefully lift compressor pump to clear the power board shield.
6. Access the 12-pin scroll pump connector and disconnect from the driver transition board.
7. Remove the (2) KEPS nuts on the scroll compressor board (1) on the right and (1) on the front.
8. Scroll pump is now completely detached.
9. Remove from the unit and set aside.

Note

Compressor power board should be placed in an antistatic bag.

Installation

1. Slide the compressor/scroll pump in the front right side of the ventilator and position over the (4) studs.
2. Install ground wire over right front stud and secure with one of the 11/32 KEPS nuts.
3. Secure compressor using the (4) 11/32 KEPS nuts over the (4) studs.

4. Connect 8-pin molex connector from compressor to compressor control board.

Note

Ensure the scroll compressor assembly is seated below the wire that runs from the driver transition board to the fan and push down the wire harness from the driver transition board under the front of the scroll pump to avoid wedging it between the scroll pump and the chassis

5. Position the scroll compressor board onto two studs and secure with (2) KEPS nuts; (1) on the right and (1) on the front. 33928 (Blue) Filter & 33929 (White) Filter.
6. Reattach the high pressure hose to the filter outlet.
7. Referring to the instructions in this chapter, re-install the following components:
   - UIM and the top cover.

EPM Board P/N 51000-40848

Removal

1. Referring to the instructions in this chapter, remove the following components:
   - UIM and the top cover.
2. Disconnect all of the tubing to the EPM board.
3. Disconnect the ribbon cable (R07) from the driver transition board by depressing the locking tabs on either side and pulling on the connector.

CAUTION

Never pull on a cable during disconnection.

4. Disconnect the 10-pin ribbon cable at JP1 and 4-pin wire cable to the front interface panel at JP5.
5. Remove the 2 Phillips screws on the top of the board and pull it out of the chassis.

Installation

1. Position the EPM board so that the notches at the bottom, line up with the two studs on the middle of the chassis (see diag) and secure with (2) SEMS screws at the top of the board.

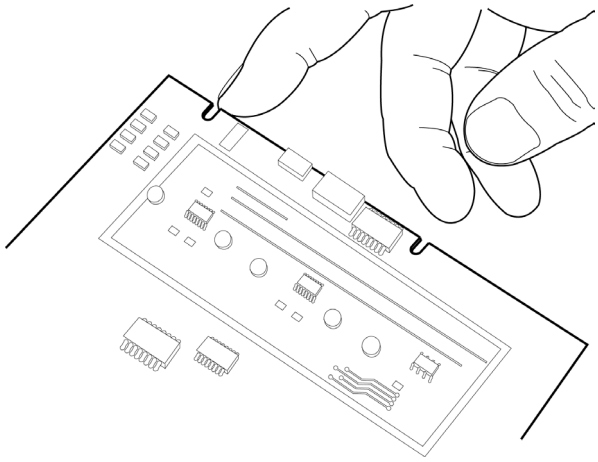


Figure 4.13 EPM Board alignment notches

Note

Ensure that you do not pinch any tubing since this can result in damage to the AVEA.

2. Connect the 10-pin ribbon cable to JP1 and 4-pin wire cable to the front interface panel to JP5.
3. Connect 24 pin ribbon cable (51000-40782) to JM1.
4. Connect the 4-pin wire cable to the front interface panel to JP5.
5. Connect the tubing. Connect clear tubing with inline orifice to the 90 degree barbed elbow fitting closest to the front of the ventilator.
6. Connect clear tubing with black stripe to the 90 degree barbed elbow fitting second closest to the front.
7. Connect green tubing to the same 90 degree barbed elbow fitting third closest to the front of the ventilator.
8. Connect the clear 1/8 tubing to the brass elbow.
9. Referring to the instructions in this chapter, re-install the following components:
    - UIM and the top cover

Fan Assembly P/N 15891

Removal

1. Referring to the instructions in this chapter, remove the following components:
    - UIM and the top cover.
2. Disconnect the fan cable from the wire harness of the TCA board.
3. Pop off the fan filter cover.
4. Remove the filter and the filter cover.
5. Remove the (4) 2.5” Phillips screws holding the fan filter housing. Remove the fan assembly and the fan cover.

Installation

1. Insert the honeycomb shield into the shroud.
2. Insert the fan assembly into the shroud, ensuring the wire assembly is facing towards the lower outside corner of the ventilator.
3. Align the fan cover on the outside of the chassis and the fan assembly on the inside using (1) screw to assist in positioning.
4. Secure both the fan cover and the fan assembly with (4) 2.5” Phillips screws.
5. Connect the fan cable to the TCA wire harness.
6. Tuck the wire harness along side the fan between the fan and the outer wall of the unit.
7. Place the filter inside the filter cover so that the locking tabs face the chassis and snap the filter cover into place.
8. Referring to the instructions in this chapter, install the following components:
    - UIM and the top cover.

Power Supply P/N 68273

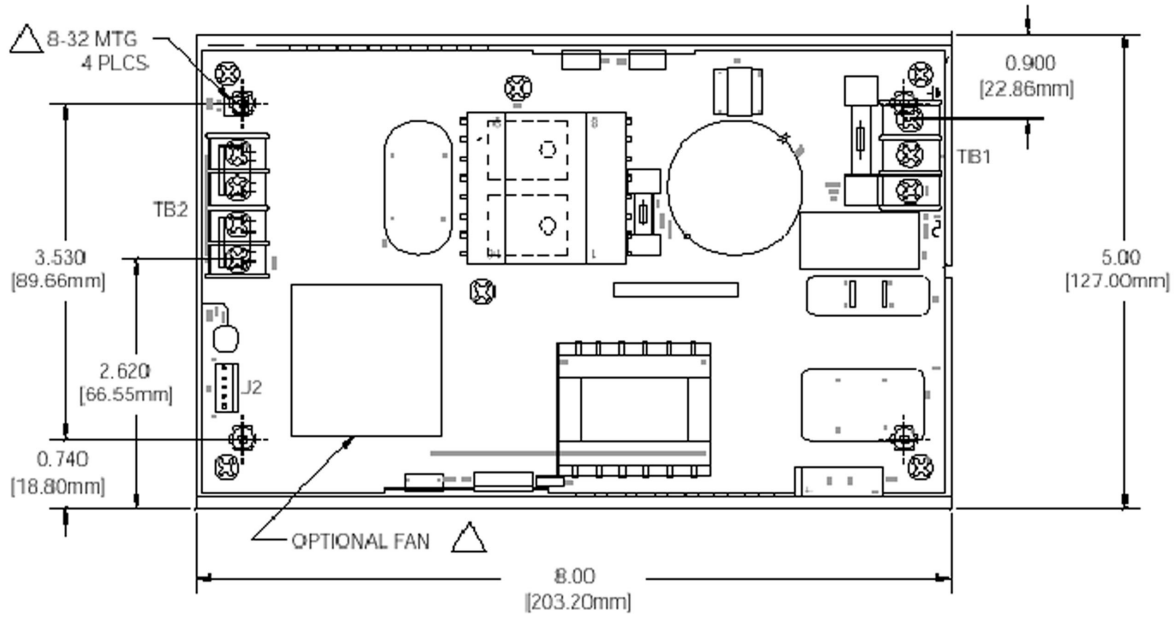


Figure 4.14 Power Supply

Tools Required

- Phillips #2 screwdriver with 8" shaft
- 11/32 nut driver
- 3/8 nut driver
- Side cutters
- Needle-nosed pliers

Removal

1. Referring to the instructions in this chapter, remove the following components in the following order:
   - UIM and the top cover.

Note

To gain access to the power supply, the aluminum shield under the plastic top cover must also be removed. There are (19) SEMS screws; (3) on the left, (5) on the right and (11) on top.

   - Fan assembly
   - EPM board (It is not necessary to remove this board when gaining access to the power supply. Please see instructions at the end of this procedure).
   - Scroll pump/compressor.
2. Cut and remove all cable ties that secure the wire assemblies to the power shield.
3. Disconnect the 5-pin connector at J2.

NOTE

It is suggested to label the (2) remaining (white) wires connected to the 4-pin terminal block as #1 and #3 as printed on the power supply circuit board.

2. Using a Phillips screwdriver, loosen the screws of the terminal block that secures wires #1 and #3 and remove.
3. Remove and label blue (neutral) and brown (load) wires on the power entry module.
4. Remove the (4) 11/32 KEPS nuts (2) on the left and (2) on the right. Pull out the power supply including the brass bracket. Part number:

Installation

1. If installing a new power supply, you will need to install (4) cable mounts on the new power supply. Use the old power supply as a model for the location on the new power supply.
2. Reconnect the (3) wires from the power entry module to the 3-pin terminal block of the power supply board.
3. Seat the power supply and the bracket into the chassis and secure with (4) 11/32 KEPS nuts; (2)
4. on the left and (2) on the right.
5. Reconnect the (2) wires, # 1 and #3 from the terminal block.
6. Reattach the 5-pin connector to the power supply board location J2.
7. Replace the cable ties.
8. Reinstall lock washer, ground wire and nut securely.
9. Secure wiring harness with cable ties to power supply shield.
10. Referring to the instructions in this chapter, install the following components in the order listed:
    - Scroll Pump / Compressor
    - EPM board. (If not removed, return the EPM to its' position on the (2) mounting studs and secure using the (2) Phillips screws.
    - Fan assembly.
    - Scroll compressor.
    - UIM and the top cover.

Table 4.1: AVEA Power supply specifications

INPUT	OUTPUT
TB1	TB2
6-32 3 pin terminal block	6-32 4 pin terminal block 0.375 ctr
PIN 1 AC line	Bus bar with 10-32 screw on high current models
Pin 2 AC neutral	Pins 1 and 2 +V out
Pin 3 AC ground	Pins 3 and 4 Return
	16A max recommended current per connector pin
Signals J2	
Amp PCB Header P/N 640465-5	

Mating connector P/N 640621-5

Pin 1 DC Good
Pin 2 Power fail
Pin 3 Ext off
Pin 4 + Sense
Pin 5 -Sense

Fan

AMP PCB Header P/N 640465-2 Maximun screw protrusion above chassis = 0.120”
Mating Connector P/N 640621-2
Pin 1 - Weight 2.9 lbs (1.32Kg) max.
Pin 2 +

To Clear EPM Board From Workspace During Replacement Of Power Supply:

1. Remove the (2) Phillips screws that secure the EPM to the center bracket.
2. Pull firmly, straight up. This action will release the EPM board from the mounting studs.
3. Without disconnecting any tubes, hoses or wires, place the EPM board into a static bag and set out of the way of the compressor and power board.

Exhalation Valve and Flow Sensor Assembly P/N 51000-40076

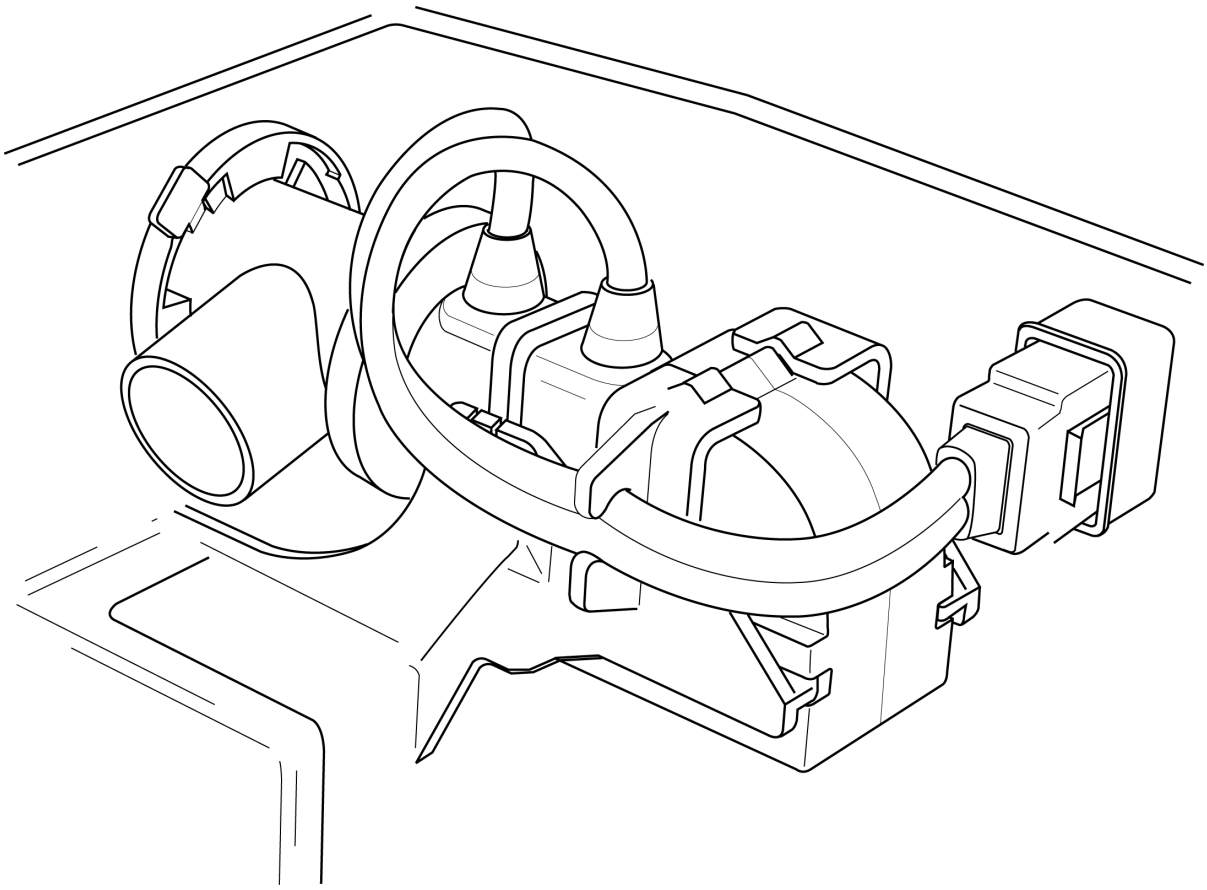


Figure 4.15 Exhalation Valve and Flow Sensor Assembly

Removal

1. Referring to the instructions in this chapter, remove the following components:
   - UIM and the top cover.
   - Exhalation filter & watertrap.
2. Remove the third (and last) screw from the exhalation assembly cover of the left hand corner of the AVEA. Remove the cover.
3. Pull the locking shroud of the connector back and disconnect the sensor from the chassis.
4. Grasp the rubber elbow and slide it towards you and remove.
5. Gently remove the exhalation flow sensor by pulling straight towards you.
6. Push in the locking tab on the exhalation valve body and twist the body counterclockwise to remove.
7. Remove the silicon diaphragm from the exhalation valve assembly.
8. Disconnect the two wires from the wiring harness.
9. Carefully cut the cable tie retaining the exhalation valve.

10. Remove the (2) KEPS nuts and Phillips screws from the top and bottom of the exhalation valve assembly and the bracket. (recommend using a 3/8 box or open-end wrench for this task)
11. Remove the exhalation valve by sliding it out of the brackets and slightly spreading the mount so as not to damage the wires..

CAUTION

Ensure that you do not damage the small wires when removing the exhalation valve.

Installation

1. Position the exhalation assembly onto the chassis by lining up the screw holes on the front panel and sliding it into the exhalation valve bracket.

CAUTION

Ensure that you do not damage the small wires when installing the exhalation valve.

2. Install the (2) Phillips screws through the top and bottom of the exhalation valve assembly and the bracket and secure with (2) KEPS nuts.
3. Connect the cables to the wiring harness.
4. 4. Leaving room for the gas delivery engine, run the wire harness under the tab in the exhalation valve assembly bracket.
5. Insert the silicon diaphragm into the exhalation valve body by seating it into the lip with the point out.
6. Install the exhalation valve body; line up the flange on the valve body with the tabs on the receptacle and twist clockwise until secure.
7. Install the exhalation flow sensor by sliding it into the gasket with the tubing facing up and ensure the tubing is under the retaining notch.
8. Slide the blue rubber elbow sensor boot in by lining it up with the grooves.
9. Attach the connector to the chassis by pulling back the plastic sleeve and pushing it into place.
10. Push the locking clip back to secure the sensor.
11. Reinstall the exhalation assembly cover using 2 of the 3 screws (side and bottom front).
12. Referring to the instructions in this chapter, re-install the following components:
    - UIM and the top cover.

Heater Assembly P/N 51000-40824

Removal

1. Remove the (4) Phillip #1screws holding the shield.
2. Remove (2) KEP nuts at the base.
3. Disconnect the 3-pin and 2-pin connectors and label.
4. Remove (2) 11/32 KEP nuts on the back of the front panel shielding the flow sensor PCB.
5. Remove (2) Phillips #2 screws from the front panel.

6. Remove corner piece
7. Remove screws (4) Phillip #1 holding shield.
8. Remove heater assembly
9. The top cover.
    - Exhalation Valve and Flow Sensor Assembly
    - Remove the screws holding the shield and remove shield.
    - Remove heater assembly

Installation

When removing and installing the corner and heater assembly, do not replace the plastic piece of the front panel or the bottom piece of the ventilator until corner/heater assembly is in place.

1. Referring to the instructions in this chapter, install the following components:
2. Reinstall heater assembly into the shield using (4) Phillips #1 screws.
3. Attach corner to the base assembly using (3) KEPS nuts and (2) Phillips #2 screws.
    - Re-attach heater.
    - Re-attach shield.
    - Exhalation Valve and Flow Sensor Assembly
    - UIM and the top cover.

Microswitch, Top Cover P/N 68294

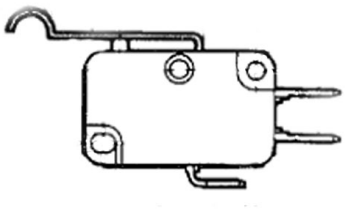


Figure 4.16 Top Cover Microswitch

Removal

1. Referring to the instructions in this chapter, remove the following components:
    - UIM and the top cover.
2. Remove attachment screws, disconnect and lift off the microswitch.

Installation

1. Reattach using screws provided. Re-connect the wiring.
2. Referring to the instructions in this chapter, install the following components:
    - UIM and the top cover.

EMI Shield

Removal

1. Referring to the instructions in this chapter, remove the following components:
   - UIM and the top cover.
2. Remove the protective box cover by removing the (1) Phillips screw.
3. Remove the EMI shield protective box by removing the (2) KEPS nuts that secure it.

Installation

1. Replace the EMI shield protective box and secure it with (2) KEPS nuts.
2. Replace the protective box cover and secure with (1) Phillips screw.
3. Referring to the instructions in this chapter, install the following components:
   - UIM and the top cover.

Front Interface Panel P/N 51000-40635

Removal

1. Referring to the instructions in this chapter, remove the following components:
   - UIM and the top cover.
   - Ventilator assembly (from the base).
   - Gas delivery engine assembly.
2. Remove the flow sensor cover by removing the (3) SEMS screws.
3. Remove the (2) KEPS nuts, the EMI shield, brass bracket, and ribbon cable.
4. Turn the unit over and support it on 2x4 pieces of wood so as not to put the entire weight of the unit on the 4 standoffs.
5. Remove (7) Phillips screws; (2) from the lower back panel and (5) from the bottom panel.
6. Remove bottom panel
7. Remove (2) screws from the top of the front panel.
8. Loosen (2) KEPS nuts from the bottom that hold the front panel.
9. Pull off the front panel.
10. Loosen (1) KEPS nut from the bottom and (4) screws on the front panel.
11. Remove the blue tubing from the nebulizer to the front panel.
12. Gently pull the blue ribbon cable through the narrow slot at the top center of the front interface panel and the rest of the wiring through the recessed compartment in the chassis.

Installation

1. Gently feed the blue ribbon cable through the narrow slot at the top center of the front panel and the wiring through the recessed compartment in the chassis.
2. Attach the blue tubing from the nebulizer to the front panel.

3. Tighten (1) KEPS nut on the bottom and (4) screws on the front interface panel.
4. Position the front panel and install (2) KEPS nuts on the bottom and (2) screws on the bottom of the front panel.
5. Position the back panel and install (7) Phillips screws; (2) on the lower back panel and (5) on the bottom panel.
6. Turn the unit over.
7. Install the (2) KEPS nuts, the EMI shield, brass bracket, and ribbon cable.
8. Attach the flow sensor cover by installing the (3) SEMS screws.
9. Referring to the instructions in this chapter, install the following components:
   - Ventilator assembly onto the base.
   - Gas delivery engine assembly.
   - UIM and the top cover.

Driver transition board P/N 51000-40829

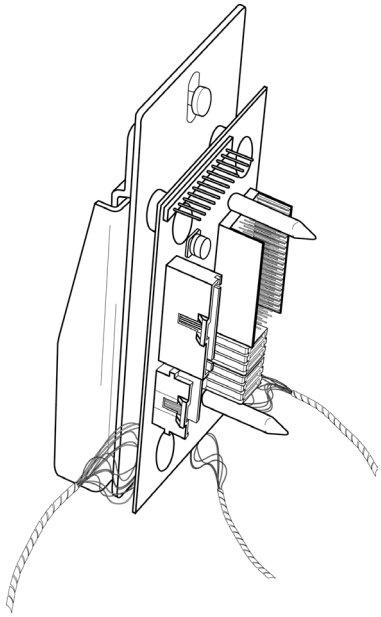


Figure 4.17 Driver transition board

Removal

1. Referring to the instructions in this chapter, remove the following:
   - UIM and the top cover.
   - Gas delivery engine assembly.
   - Fan assembly connections
   - Scroll compressor connections.
   - Front interface panel connections.
2. Disconnect the wiring to the power supply board and the battery.

3. Remove the spiral wrap to the alarm connector, and feed the wires out of the hole in the chassis one connector at a time.
4. Remove the (2) Phillips screws and flat washers from the chassis.
5. Remove the Phillips screws on the board bracket and remove the board from the bracket.

Installation

1. Mount the driver transition board into the first half of the bracket; place the board on the three round threaded studs with the cables spread outward, and secure the (3) Phillips screws.
2. Place the flat side of the other half of the bracket on the two mounting pins and slide it down.
3. Install (1) Phillips screw from the front to the rear of the bracket and leave finger tight.
4. Align the bracket over the two threaded holes in the chassis and install (2) Phillips screws using flat washers.
5. Align the driver transition board; slide in the gas delivery engine assembly, carefully connect it to the driver transition board, adjusting the bracket as necessary.
6. Once the alignment is complete, secure the driver transition board and the height adjustment pin on the bracket, and then remove the gas delivery engine assembly.
7. Feed the top wiring harness through the small hole in the front right of the chassis, one connector at a time.
8. Install the spiral wrap, leaving the alarm connector hanging off to the side.
9. Make the appropriate connections to the power supply board and to the battery.
10. Referring to the instructions in this chapter, install the following components:
    - Front interface panel.
    - Scroll compressor.
    - Fan assembly.
    - Gas delivery engine assembly.
    - UIM and the top cover.

Alarm Speaker P/N 51000-40818

Removal

1. Referring to the instructions in this chapter, remove the following components:
    - UIM and the top cover.
    - Ventilator assembly from the base.
    - Bottom cover.
    - Front panel.
2. Turn the unit over and support it on 2x4 pieces of wood to avoid putting the entire weight of the unit on the 4 standoffs.
3. Disconnect the wire to the driver transition board.
4. Remove the (2) 11/32 KEPS nuts that secure the speaker and lift the speaker off of the threaded studs.

Installation

1. Position the speaker onto the two threaded studs and secure with (2) 11/32 KEPS nuts.
2. Connect the wire to the driver transition board.
3. Referring to the instructions in this chapter, install the following components:
   - Bottom cover.
   - Front panel.
   - Ventilator assembly onto the base.
   - UIM and the top cover.

Nebulizer P/N 51000-40818

Removal

1. Referring to the instructions in this chapter, remove the following components:
   - UIM and the top cover.
   - Ventilator assembly from base.
   - Bottom cover.
2. Cut tie wraps on the nebulizer booster.
3. Remove wire harness.
4. Disconnect the two solenoid connectors to the driver transition board.
5. Disconnect the tubing from the accumulator.
6. 6 Remove the (3) KEPS nuts that secure the nebulizer; (2) on the left side and (1) on the right, Maneuver the nebulizer out from behind the accumulator.
7. Disconnect blue tube just in front of the solenoid.

Installation

1. Turn the unit over and support it on 2x4 pieces of wood so as not to put the entire weight of the unit on the 4 standoffs.
2. Position the nebulizer onto the three threaded studs and using ong needle-nosed pliers, secure with (3) 11/32 KEPS nuts; (2) on the left side and (1) on the right.
3. Connect the tubing from the accumulator to the left side of the nebulizer.
4. Feed the tubing from the gas delivery engine through the U-shaped notch on the left side of the chassy and connect it to the nebulizer.
5. Connect the two solenoid connectors from the driver transition board.
6. Referring to the instructions in this chapter, install the following components:
   - Bottom cover.
   - Gas delivery engine assembly.
   - UIM and the top cover.

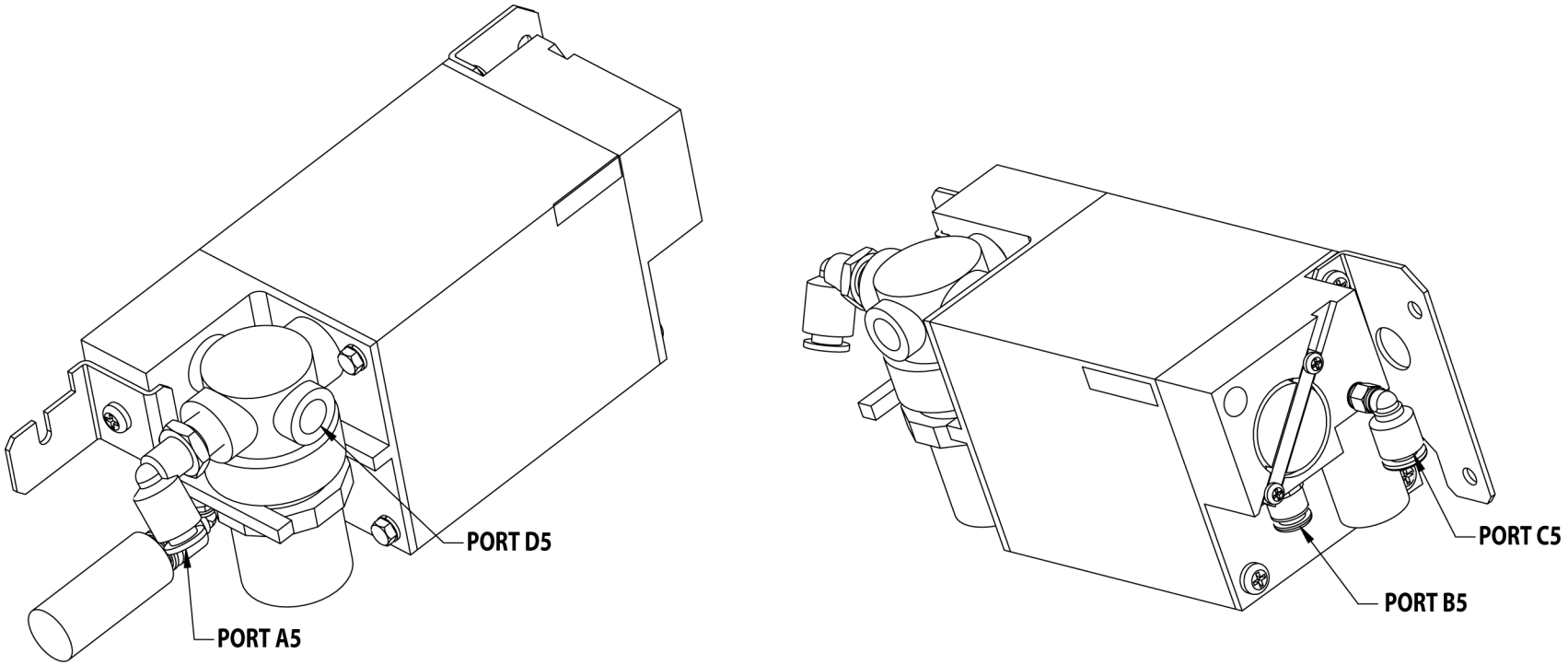


Figure 4.18: Nebulizer Assembly showing ports

Accumulator P/N 51000-40748

Removal

1. Referring to the instructions in this chapter, remove the following components:
   - UIM and the top cover.
   - Gas delivery engine assembly.
   - Ventilator assembly from base.
   - Bottom cover.
   - Front panel.
   - Speaker.
   - Nebulizer.
2. Disconnect the solenoid cable from the driver transition board.
3. Disconnect the tubing from the solenoid drain panel.
4. Remove the (4) 11/32 KEPS nuts; one from each corner.
5. Remove the accumulator, twisting to carefully remove the gas delivery engine supply tubing out of the slot on the bottom left of the chassis.

Installation

1. Turn the unit over and support it on 2x4 pieces of wood so as not to put the entire weight of the unit on the 4 standoffs.
2. Rotate the supply tube to the gas delivery engine into the slot on the bottom left of the chassis.
3. Position the accumulator by sliding the two notches over the threaded studs at the bottom and seating the top onto the two mounting studs.
4. Secure the accumulator with (4) 11/32 KEPS nuts, one on each corner.
5. Connect the tubing to the solenoid drain panel.
6. Connect the solenoid cable to the driver transition board.
7. Referring to the instructions in this chapter, install the following components:
   - Speaker.
   - Bottom cover.
   - Front panel.
   - Nebulizer.
   - Ventilator assembly onto the base.
   - Gas delivery engine assembly.
   - UIM and the top cover.

Chapter 5 Operational Verification Procedure (OVP)

WARNING

Verification Testing should always be done off patient.

Set up

1 Plug the AVEA into a suitable AC Power source and connect an adult patient circuit and an adult test lung.

NOTE

Manufacturer recommends the use of a nondisposable adult patient circuit and test lung in testing VIASYS ventilatory equipment:.

2 Turn power on.

3 Select ***New Patient*** when prompted. The ***Safety Valve Open*** alarm will activate. Press ***Patient Accept***. (This will re-set the controls to the default settings shown at the end of this procedure).

4 Select ***Patient Size*** and select ***Adult***. Press ***Size Accept.*** Leave the settings at the defaults and verify that a Vent-Inop. Alarm is not activated.

5 Ensure that ***Leak Comp*** and ***Humidifier active*** are off. Press ***Setup Accept.***

User Verification Tests (UVT)

The following tests are part of the User Verification testing performed before connection to a new patient.

The POST test

The first part of the testing, the **POST** or Power On Self Test is transparent to the user and will only message if the ventilator encounters an error. This test is run automatically and performs the following checks:

- Processor Self Check
- ROM Check Sum
- RAM Test

The POST will also check the audible alarms and the LEDs at which time the audible alarm sounds and the LEDs on the User Interface Module flash. Normal ventilation commences at the culmination of the POST.

Extended Systems Test (EST)

1 Connect a medical grade oxygen source to the unit (20 TO 80 psi).

2 Press the Setup membrane button to access the Setup screen.

3 Press ***Size Accept*** to pass the next displayed screen.

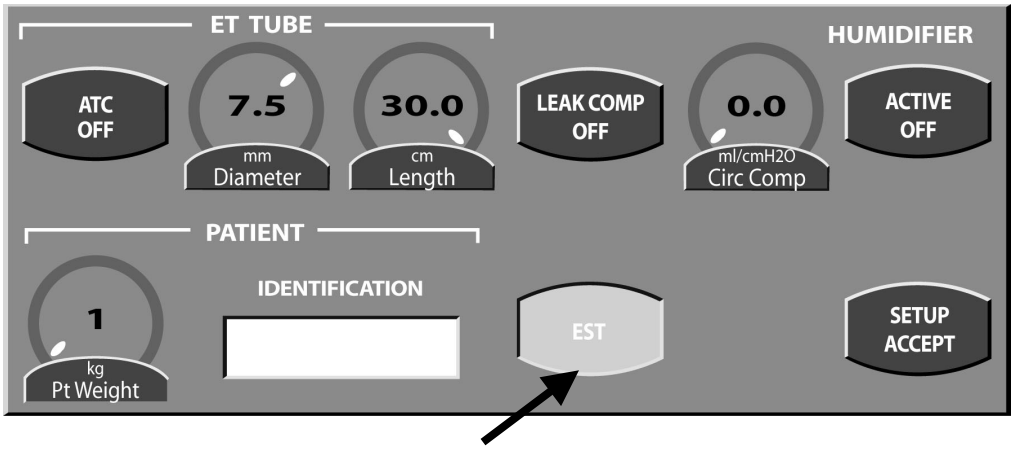


Figure 5.1

4 Press the EST touch screen icon to highlight. (A message will appear instructing you to remove the patient and block the patient circuit wye.) Remove the test lung and plug the wye connector.

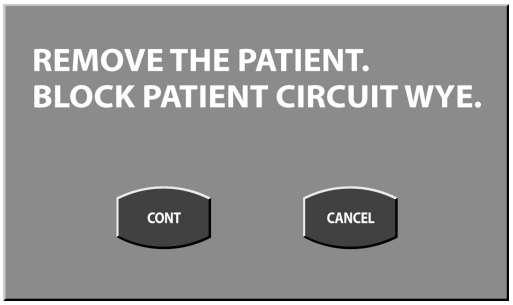


Figure 5.2

5 After confirming that the patient has been disconnected and the circuit wye blocked press the Continue (Cont) button. (The ventilator will perform the EST and display a countdown clock.)

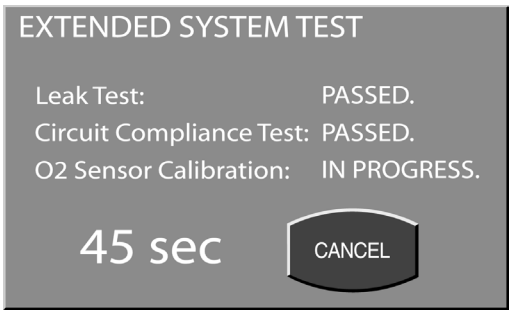


Figure 5.3

During this test the ventilator will perform:

- Patient circuit leak test
- Patient circuit compliance measurement
- Two point calibration of the oxygen sensor

The patient circuit compliance measurement and leak test are performed simultaneously with the oxygen sensor calibration. The maximum time for the EST is 90 seconds.

To restart the EST at any time select the Cancel button to return to the set up screen.

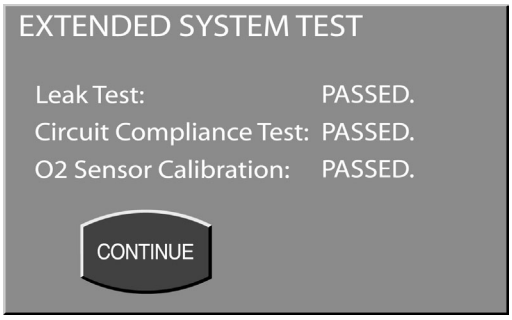


Figure 5.4

After each test is complete the ventilator will display a “Passed” or “Failed” message next to the corresponding test.

Once the test is complete press the continue button to return to the set up screen.

Note

If you do not connect the ventilator to an oxygen supply, the O2 Sensor Calibration will immediately fail.

Manual Alarms Testing

This testing verifies the following alarms:

Low PEEP alarm	Low O_2 alarm
High Ppeak alarm	High O_2 alarm
High Ppeak, Sust	Low Ppeak alarm
Low Ve alarm	Loss of AC alarm
High Ve alarm	Circuit Disconnect
High Vt alarm	High Rate Alarm
Low Vt alarm	Apnea Interval alarm

CAUTION

Although failure of any of the above tests will not prevent the ventilator from functioning, it should be checked to make sure it is operating correctly before use on a patient.

Note

To ensure proper calibration of the oxygen sensor, you should always perform an EST prior to conducting Manual Alarms Testing.

WARNING

User Verification Testing should always be done off patient.

CAUTION

Following each alarm verification test, ensure that the alarm limits are reset to the recommended levels shown in this chapter before proceeding to the next test.

Table 5.1: Test Setup Requirements

	Adult Setting	Pediatric Setting	Neonate Setting
Air Supply Pressure	20-80 psig (2.1 bar)	Same	Same
O2 Supply Pressure	20-80 psig (2.1 bar)	Same	Same
AC Line Voltage	Varies Internationally	Same	Same
Patient Circuit	6' (2 m) Adult	6' (2 m) Adult	Infant
Compliance	20 ml/cmH2O	20 ml/cmH2O	N/A
Resistance	5 cmH20/L/sec	5 cmH20/L/sec	N/A

To conduct Manual Alarms Testing on the AVEA ventilator using default settings, complete the following steps (A table describing the default settings for Adult, Pediatric and Neonatal patient sizes is included in this manual).

Table 5.2: Ventilation Setup

Vent Setup	Adult Setting	Pediatric Setting	Neonate Setting
ET tube Diameter	7.5 mm	5.5 mm	3.0 mm
ET Tube Length	30 cm	26 cm	15 cm
Artificial Airway Compensation	Off	Off	Off
Leak Compensation	Off	Off	Off
Circuit Compliance Compensation (Circ Comp)	0.0 ml/cmH2O	0.0 ml/cmH2O	ml/cmH2O NOT active in Neonates.
Humidification	Active On	Active On	Active On
Patient Weight	1 kg	1 kg	1 kg

Table 5.3: Primary Controls

	Adult Setting	Pediatric Setting	Neonate Setting
Breath Type/Mode	Volume A/C	Volume A/C	TCPL A/C
Breath Rate (Rate)	8 bpm	12 bpm	20 bpm
Tidal Volume (Volume)	500 ml	100 ml	N/A
Peak Flow	60 L/min	20 L/min	8 L/min
Inspiratory Pressure (Insp Pres)	15 cmH_2O	15 cmH_2O	15 cmH_2O
Inspiratory Pause (Insp Pause)	0.0 sec	0.0 sec	0.0 sec
Inspiratory Time (Insp Time)	0.5 sec	0.5 sec	0.35 sec
PSV	0 cmH_2O	0 cmH_2O	0 cmH_2O
PEEP	6 cmH_2O	6 cmH_2O	3 cmH_2O
Inspiratory Flow Trigger (Flow Trig)	1.0 L/min	1.0 L/min	1.0 L/min
$\%O_2$	21%	21%	21%

Table 5.4: Advanced Settings

Adv. Settings	Adult Setting	Pediatric Setting	Neonate Setting
Vsync	**0 (off)**	**0 (off)**	**N/A**
Vsync Rise	**5**	**5**	**N/A**
Sigh	**0 (off)**	**0 (off)**	**N/A**
Waveform	**1 (Dec)**	**1 (Dec)**	**1 (Dec)**
Bias Flow	**2.0 L/min**	**2.0 L/min**	**2.0 L/min**
Inspiratory Pressure Trigger (Pres Trig)	**1.0 cmH_2O**	**1.0 cmH_2O**	**1.0 cmH_2O**
PSV Rise	**5**	**5**	**5**
PSV Cycle	**25%**	**25%**	**10%**
PSV Tmax	**5 sec**	**5 sec**	**1.5 sec**
Machine Volume (Mach Vol)	**0 L**	**0 ml**	**0 ml**
Volume Limit (Vol Limit)	**2.50 L**	**500 ml**	**300.0 ml**
Inspiratory Rise (Insp Rise)	**5**	**5**	**5**

Adv. Settings	Adult Setting	Pediatric Setting	Neonate Setting
Flow Cycle	**0% (off)**	**0% (off)**	**0% (off)**
T High PSV	**Off**	**Off**	**N/A**
T High Sync	**0%**	**0%**	**N/A**
T Low Sync	**0%**	**0%**	**N/A**

Table 5.5: Alarm Settings

	Adult Setting	**Pediatric Setting**	**Neonate Setting**
High Rate	200 bpm	200 bpm	200 bpm
High Tidal Volume (High Vt)	3.00 L	1000 ml	300 ml
Low Tidal Volume (Low Vt)	0.0 L	0.0 ml	0.0 ml
Low Exhaled Minute Volume (Low Ve)	0.0 (off)	0.0 (off)	0.0 (off)
High Exhaled Minute Volume (High Ve)	30.0 L/min	30.0 L/min	5.0 L/min
Low Inspiratory Pressure (Low Ppeak)	3 cmH_2O	3 cmH_2O	3 cmH_2O
High Inspiratory Pressure (High Ppeak)	75 cmH_2O	75 cmH_2O	50 cmH_2O
Low PEEP	3 cmH_2O	3 cmH_2O	1 cmH_2O
Apnea Interval	20 sec	20 sec	20 sec

Table 5.6: Auxiliary Controls

	Adult Setting	**Pediatric Setting**	**Neonate Setting**
Manual Breath	**---**	**---**	**---**
Suction	**---**	**---**	**---**
↑ O2	**---**	**---**	**---**
Nebulizer	**---**		
Inspiratory Hold (Insp Hold)	**---**	**---**	**---**
Expiratory Hold (Exp Hold)	**---**	**---**	**---**

1. Make the appropriate connections for air and O2 gas supply. Connect the power cord to an appropriate AC outlet. Attach an appropriate size patient circuit and test lung to the ventilator.
2. Power up the ventilator and select “NEW PATIENT” when the Patient Select Screen appears. Accept this selection by pressing “PATIENT ACCEPT”. This will enable default settings for the Manual Alarms Test.
3. Select the appropriate patient size for your test (Adult, Pediatric or Neonate) from the Patient Size Select Screen. Accept this selection by pressing “SIZE ACCEPT”. Set *Humidifier Active* off.
4. Make any desired changes or entries to the Ventilation Setup Screen and accept these by pressing “SETUP ACCEPT”.
5. Press *Alarm Limits* button on the upper right of the user interface.
6. Verify that no alarms are active and clear the alarm indicator by pressing the alarm reset button on the upper right of the user interface.
7. Set the % O_2 control to 100%. Disconnect the Oxygen sensor from the back panel of the ventilator and verify that the Low O_2 alarm activates. Return the O_2 control setting to 21% with the sensor still disconnected from the rear panel. Remove sensor from back panel. Provide blow-by to the sensor from an external oxygen flow meter. Verify that the High O_2 alarm activates. Return the % O_2 to 21%, reconnect the Oxygen sensor to the back panel. Clear all alarm messages by pressing the alarm reset button.
8. Set *PEEP* to 0. Set *Low PEEP* alarm to 0. Disconnect the patient wye from the test lung. Verify that the Low Ppeak alarm activates, followed by the Circuit Disconnect alarm. This second alarm should activate after the default setting of 20 seconds for the apnea interval has elapsed. Reconnect the test lung to the circuit clear the alarm by pressing the reset button.
9. Disconnect the AC power cord from the wall outlet. Verify that the Loss of AC alarm activates. Reconnect the AC power cord. Clear the alarm by pressing the reset button.
10. Occlude the exhalation exhaust port. Verify that the High Ppeak alarm activates, followed 5 seconds later by the activation of the High Ppeak, Sust. alarm.
11. Set the control setting for rate to 1 bpm. Verify that Apnea Interval alarm activates after the default setting of 20 seconds. Return the control setting to its default value and clear the alarm by pressing the reset button.
12. Set the Low PEEP alarm setting to a value above the default control setting for PEEP on your ventilator. Verify that the Low PEEP alarm activates. Return the alarm setting to its default value and clear the alarm by pressing the reset button.
13. 13.Set the High Ppeak alarm setting to a value below the measured peak pressure or in neonatal ventilation, the default control setting for Inspiratory Pressure on your ventilator. Verify that the High Ppeak alarm activates. Return the alarm setting to its default value and clear the alarm by pressing the reset button.
14. 14.Set the Low Ve alarm setting to a value above the measured Ve on your ventilator. Verify that the Low Ve alarm activates. Return the alarm setting to its default value and clear the alarm by pressing the reset button.
15. 15.Set the High Ve alarm setting to a value below the measured Ve on your ventilator. Verify that the High Ve alarm activates. Return the alarm setting to its default value and clear the alarm by pressing the reset button.
16. Set the High Vt alarm setting to a value below the set Vt on your ventilator. Verify that the High Vt alarm activates. Return the alarm setting to its default value and clear the alarm by pressing the reset button.

17. Set the Low Vt alarm setting to a value above the set Vt on your ventilator. Verify that the Low Vt alarm activates. Return the alarm setting to its default value and clear the alarm by pressing the reset button.
18. 18.Set the High Rate alarm to a value below the default control setting for rate on your ventilator. Verify that the alarm activates. Return the alarm to its default setting and clear the alarm by pressing the reset button.

NOTE

Repeat steps 11 through 17 with a pediatric circuit and test lung.
Repeat steps 11 through 17 with an infant circuit and test lung.

CAUTION

Although failure of any of the above tests will not prevent the ventilator from functioning, it should be checked to make sure it is operating correctly before use on a patient.

User Interface Module (UIM) Verification

Membrane Switch Tests

These tests verify the functioning of the membrane buttons surrounding the touch screen:

1. Alarm Silence (LED) - Disconnect the test lung from patient circuit. An audible alarm sounds. Press the Alarm Silence button and verify that the audible portion of the alarm is disabled for 2 minutes (± 1 second)or until the Alarm Silence button is pressed again.
2. Alarm Reset - Reconnect the test lung to the patient circuit. The alarm message should turn yellow. Press the Reset button to cancel the visual alarm message.
3. Alarm Limits - Press the Alarm Limits screen button. Press the button again to toggle the screen on and off.
4. Manual Breath - Press this button during the expiration phase of a breath. Verify that the ventilator delivers a single mandatory breath at current ventilator settings.
5. Suction (LED) - Press the Suction button, both Suction and ↑ $\%O_2$ LEDs should Illuminate, also LOSS, O2 appears on the screen in the alarm window. Press Suction again, both Suction and ↑ $\%O_2$ LEDs should disappear, press Reset to clear visual alarm.
6. Increase O2 - Press the Increase O2 button (↑ $\%O_2$) Verify that the LED Illuminates, The LOSS O2 alarm activates. Press the button again and verify that the LED turns off. Press RESET to clear the visual alarm.
7. Accept - Change any parameters, press accept and verify the new setting is entered.
8. Cancel - Change any parameters, press Cancel ensure new setting is canceled.
9. Expiratory Hold - Press the Expiratory Hold button. The pressure waveform should display as a flat line for about 20 seconds in Adult and Pediatric Patient modes.
10. Inspiratory Hold - Allow to cycle then press this soft key & it will plateau at the top of the inspiratory cycle in the adult and pediatric patient modes.
11. Nebulizer - Connect wall air to unit 20 to 80 psi. Press the Nebulizer button, verify that nebulization is synchronized with breath rate. You will feel air coming out of the nebulizer fitting. Lower peak flow < 14L/min and “neb not available” should appear.
12. Mode - Press the Mode button. Verify that the Mode sub screen appears.
13. Patient Size - Select a Patient size from the menu. Ensure the correct LED is displayed for the patient size currently selected. Change patient size to Pediatric and then to Neonate. Verify correct LED display for each one.
14. Panel Lock - Press the Lock button and verify no access to screen functions. The manual breath, suction, increase O2 and alarm silence buttons **are** functional during panel lock.
15. Set-up - Press the Setup button and verify that the Setup screens appears. Press Size Accept, Press Set up Accept.
16. Advanced Settings - Press the Advanced Settings screen button. Toggle the screen on & off. Verify that the screen responds correctly.
17. Event - Press Events and verify the sub screen appears, press again to check that the Main screen reappears.
18. Freeze - Press the Freeze button. All graphics screen update should cease, the wave forms freeze. Measurement bar appears. Press again and ensure normal refresh of the waveform sweep continues in the Main screen.

19. Screens and Main buttons - Press the Screens button and the Screen Select screen should appear. Press Monitor, the Monitor screen should display. Press Main and the screen should go back to Main screen.

Field replacement and test of the AVEA Compressor Assembly

Refer to chapter 4 for disassembly of the User Interface Module (UIM) and top cover. Follow the instructions given in Chapter 4 to remove and replace the compressor assembly. Re-assemble the AVEA and test using this procedure.

The compressor sub-system on the AVEA includes a Compressor PC Board and the Compressor. The sub-assembly is tested and calibrated at the factory and designed to be field installed in the AVEA ventilator. This procedure verifies that the test ventilator delivers the expected minute ventilation when the compressor is supplying air to the ventilator (40 L/min). It also verifies that the compressor activates upon loss of the wall air supply and de-activates when that supply is restored.

Equipment Required

- • AVEA Ventilator (Test ventilator)
- • Adult Patient Circuit
- • Device for measuring Parabolic Airway Resistance - R_P5 (Usually available with test lung)
- • Adult Test Lung – Manley or Siemens recommended
- • Regulated Air Supply - Range > 30 psig

Note

All equipment is as stated or equivalent .

Test Procedure

1. Attach the adult patient circuit and test lung to the test ventilator. Connect to a regulated wall air supply as indicated above.
2. Turn on the ventilator and set parameters shown in the table below.
3. Turn off the wall air supply.
4. Verify that the compressor activates
5. Verify that the “scroll” symbol is displayed in the bottom right corner of the UIM
6. Verify ventilator continues to ventilate and no alarms are activated
7. Allow ventilator to continue to cycle using the compressor for approximately two minutes.
8. Disconnect the expiratory limb of circuit. The Circuit Disconnect and Low Ppeak alarms should activate.

NOTE:

Leave expiratory limb disconnected for remainder of test

9. Change the following ventilator settings:

Control	Setting
Tidal Volume (Vt)	2.0L,
Rate	19 bpm,
Peak Flow	150 L/MIN.

10. Change the scale on Flow waveform graphic display to 300 L/min.
11. Allow ventilator to cycle for approximately two minutes then Press the Alarm Reset membrane button.
12. Verify that no alarms except for Circuit Disconnect and Low Ppeak are active
13. Press the Freeze button.
14. Verify the flow at the end of inspiration is between 67 and 83 L/min.
15. Re-connect wall air supply.
16. Verify compressor shuts off and ventilation continues uninterrupted using the wall air supply.

Table 5.7: Test Ventilator: (AVEA Ventilator)

Setup	Patient Size	Adult
	ET Tube Diameter	7.5 mm
	ET Tube Length	30 cm
	Automatic Tube Compensation (ATC)	Off
	Leak Compensation	Off
	Circuit Compliance Compensation (Circ Comp)	0.0 mL/cmH2O
	Humidification	Off
	Ideal Body Weight	1 Kg
Primary Controls	Breath Type/Mode	Volume A/C
	Breath Rate (Rate)	15
	BPM	
	Tidal Volume (Volume)	0.50 L
	Peak Flow	45 L/MIN
	Inspiratory Pause (Insp Pause)	0.00 second
	Inspiratory Time (I-Time)	- - -
	PSV	- - -
	PEEP	0 cmH2O
	Inspiratory Flow Trigger (Flow Trig)	20.0 L/MIN
	% O2	21 %
Advanced Controls	Vsync	0 (Off)
	Vsync Rise	- - -
	Sigh	0 (Off)
	Waveform	Decel.
	Bias Flow	2.0 L/MIN

	Inspiratory Pressure Trigger (Pres Trig)	20.0 cmH2O
	PSV Rise	- - -
	PSV Cycle	- - -
	PSV T_{max}	- - -
	Machine Volume (Mach Vol)	- - -
	Volume Limit (Vol Limit)	- - -
	Inspiratory Rise (Insp Rise)	- - -
	Flow Cycle	- - -
Alarm Settings	High Rate	200 BPM
	High Tidal Volume (High Vt)	3.00 L
	Low Exhaled Minute Volume (Low Ve)	0 (Off)
	High Exhaled Minute Volume (High Ve)	30.00 L/MIN
	Low Inspiratory Pressure (Low PPEAK)	3 cmH2O
	High Inspiratory Pressure (High PPEAK)	50 cmH2O
	Low PEEP	0 cmH2O
	Apnea Interval	20 seconds
Auxiliary Controls	Manual Breath	- - -
	Suction	- - -
	[a] %O2	Not enabled
	Nebulizer	Not enabled
	Inspiratory Hold (Insp Hold)	- - -
	Expiratory Hold (Exp Hold)	- - -
	Air Supply Pressure	> 30 psig
	O2 Supply Pressure	> 30 psig
	AC Line Voltage	115 ± 10 VAC

Checkout Sheet – AVEA Compressor Replacement

Date: _____ Hours: _____

Old Compressor S/N: _____ New Compressor S/N: _____

AVEA Ventilator S/N: _____ UIM Serial Number: _____

TEST	PASS FAIL	
Compressor Activates when wall air is turned off		
Scroll symbol displays when compressor activates		
Ventilator continues to cycle and no alarms initiate when wall air is turned off		
Circuit Disconnect and Low Ppeak alarms initiate when circuit is disconnected		
No other alarms active after ventilator settings are changed		
Eng inspiration flow reading is between 67 and 83 L/min		
Compressor shuts off when wall air is turned on and ventilation continues uninterrupted		

I here by certify that the product with the above Serial Number has passed all operational specification and is certified for clinical use (The unit must be signed off before returning to clinical use.)

Signature: _____ Date: _____

Please complete this check sheet and fax to Regulatory Affairs at (760) 778-7301

Or mail to: Regulatory Affairs Department VIASYS Healthcare Critical care Division 1100 Bird Center Dr. Palm Springs, Ca. 92262

Power Indicators and Charging Verification.

Power the unit up. Verify the Power On indicator is lit. It will be green.

Ensure that when the unit is connected to AC Power the AC indicator is lit. It will be green.

If the unit is equipped with an external battery, check and verify the external battery charging and status indicators.

Check the internal battery (standard feature) charging and status indicators.

The charging status indicators are:

Green: unit has a full charge

Yellow: unit in process of charging

Red: unit requires charging

Proceed with the rest of the O.V.P testing.

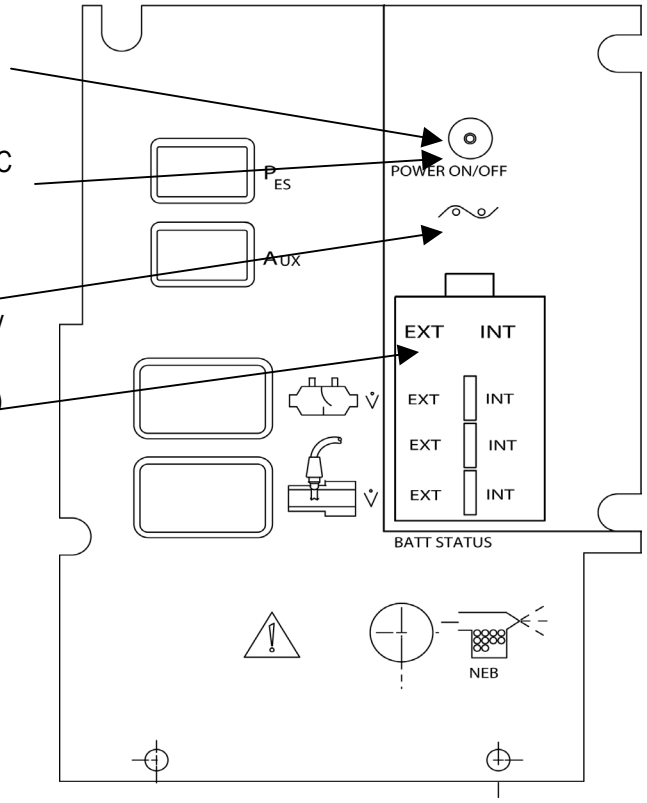


Figure 5.5

Battery Run Procedure

1. Plug unit in, turn power on and adjust settings as follows:
   a. *Mode*: Pediatric, Volume A/C
   b. *Settings:* 40 BPM, Volume 200ml, Peak Flow 30 L/min, PEEP 5cmH2O, Flow Trigger 20 L/min, and FIO2 21%.
   c. *Advanced Settings:* Vsync off, Waveform Square, Bias Flow 3 L/min, and Pressure Trigger 20cmH2O.
2. Verify that the Power Indicator “EXT” is illuminated and the Power Status is on AC (~).
3. Verify battery indicator LED’s function and progressively charge from Red to Yellow to Green.
4. Disconnect AC Power.
5. Verify that unit runs on both internal and external batteries.
6. Verify that the Power status indicator “EXT” is illuminated indicating the ventilator is running on external battery.
7. Turn unit off.

Air/Oxygen Inlet Pressure Verification.

Note

All gases used for testing the AVEA should be verified clean medical grade gas sources. The ventilator should be operating in Adult patient mode with all settings at defaults.

1. Apply a regulated 50 PSI medical air source to the AVEA Air Inlet on the rear panel of the ventilator.
2. Apply regulated 50 PSI medical O2 Source to the O2 Inlet. (Verify the Air and O2 Inlet monitors read 50 PSI (+/- 3 PSIG). You can check this by scrolling to the air inlet and O2 inlet monitored parameter displays on the left of the Main screen

   or by pressing the screens button, selecting the Monitor screen and scrolling to the air inlet and O2 inlet parameters and ***Accept.***

Figure 5.6

3. Lower the air inlet pressure gage to 18 psi. The compressor should turn on in a unit with compressor. In a unit with no compressor, the Low Air alarm should activate.

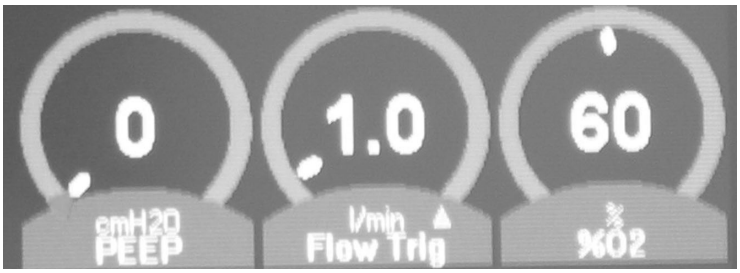


Figure 5.7

4. Change the O2 percentage to 60%.

5. Lower the O2 inlet pressure gage to 18 psi. The Low O2 alarm should activate.

Breath Rate Verification.

Note

Make sure the ventilator is set to Adult size and default settings.

1. Allow the ventilator to cycle and using a stopwatch, count the cycles and ensure the breath rate matches the Rate setting of the AVEA.
2. Verify the following rates(+/- 2)

   5 bpm

   20 bpm

   60 bpm

Blending Accuracy Verification.

Note

Make sure the ventilator is set to Adult size and default settings.

Record the readings from the external O2 Analyzer and the AVEA FIO2 (% O2) monitor/setting. Check the FiO2 (% O2) readings per table below to compare set FIO2 to analyzed FIO2.

Table 5.8: FiO2 Readings

O2%	Tidal Volume	Breath Rate	Peak Flow	% Tolerance
21%	0.50L	25	30 L/min	+/- 3%
30%	0.10	50	30 L/min	+/- 3%
30%	0.50	25	30 L/min	+/- 3%
60%	0.10	50	30 L/min	+/- 3%
60%	0.50	25	100 L/min	+/- 3%
90%	0.10	50	30 L/min	+/- 3%
90%	0.50	25	30 L/min	+/- 3%
100%	0.50	25	30 L/min	+/- 3%

PEEP Verification

1. Connect an Adult test lung and accept the default settings.
2. Change the Rate to 4 bpm. Using the Paw (cmH2O) portion of the wave form screen, freeze and measure baseline pressures at each of the following PEEP settings: (The tolerance is +/- 3.5 % of reading or +/- 2 cm.)

   6 cm

   20 cm

   40 cm

Chapter 6 AVEA Software Upgrade

This document provides a brief overview of the procedure to upgrade ventilator software using the RS232 serial port of the AVEA. The HyperTerminal utility available within the Windows environment is used here as an example. Any suitable terminal emulation software would work as well.

Requirements

- Computer with a serial port (COM1: or COM2:)
- Terminal Emulation Software (for example, HyperTerminal works well) configured for serial connection 115Kb,8,N,1 flow control OFF (see instructions below)
- AVEA ventilator with Software Upgrade Utility Version 1.0 or higher installed.
- A Serial cable to connect the computer to the serial port of the ventilator.
  (A straight-through cable with null modem adapter or null modem cable with gender changer both work fine).
- New binary files for the ventilator: 63569X.bin (Monitor) & 63568X.bin (Control). “X" indicates the revision of the released software, e.g. "63569E" is revision E.

Copying the Files

From a CD

With the CD inserted in the computer, copy the new software binary files to the computer hard drive as follows:

1. Double click on “My Computer”.
2. Double click on the CD ROM Drive to open the window & display the files.
3. Right click on each of the files displayed in turn and select Copy, then right click on the computer desktop and select Paste.
4. The files should appear on the desktop.
5. Remove the CD ROM from the computer drive.

From an e-mail attachment

1. Right click on the e-mail attachment. From the pop-up dialog box select Save As.
2. Browse to your desktop and click Save.
3. The files should appear on the desktop.

Connecting the AVEA

1. Connect the serial cable to the computer COM port selected for use (usually Com1 or Com2). Connect the other end to the ventilator serial port 1 shown here.

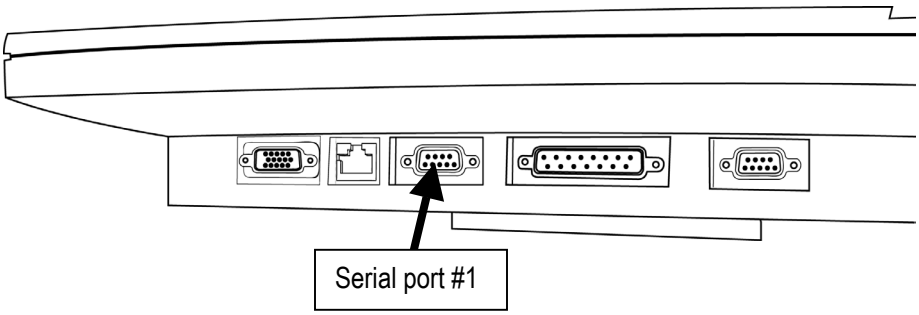


Figure 6.1: Serial port

Opening the terminal emulation software (HyperTerminal is used here)

1. From your desktop, click on the START button at the lower left of the screen.
2. From the pop-up menu, select Programs, then Accessories, then Communications.
3. When the Communications pop-up appears, click on Hyper Terminal.

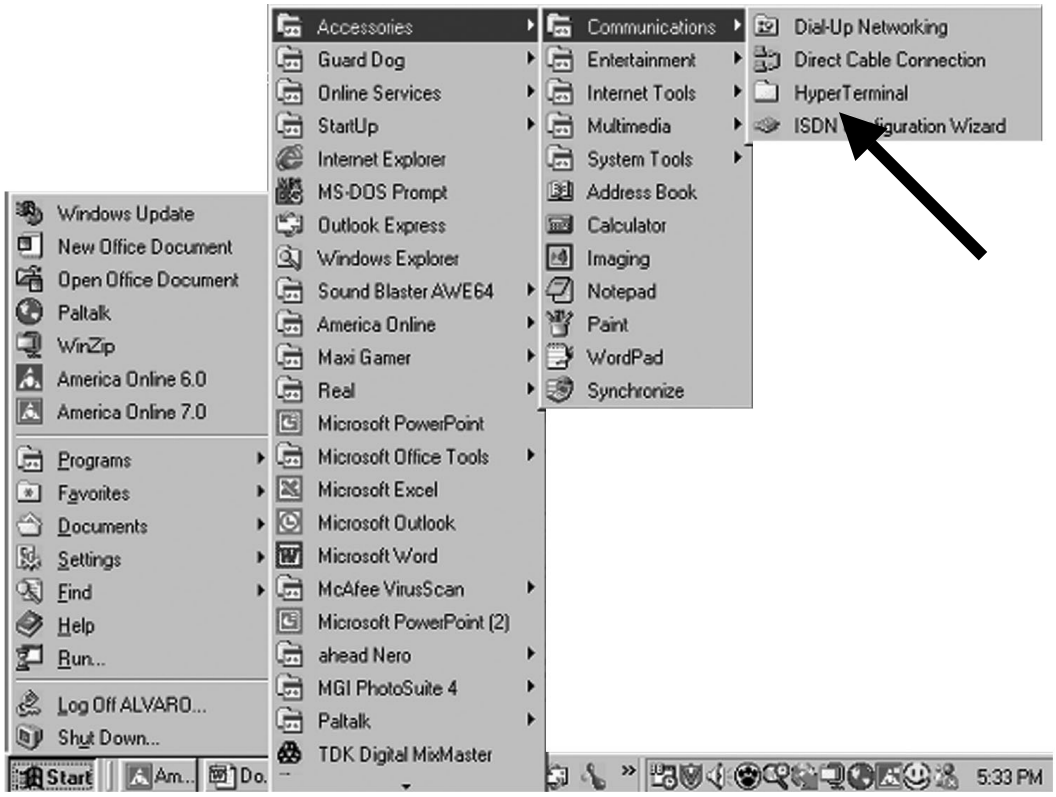


Figure 6.2: Hyper Terminal

4. Double click on the HyperTerminal icon inside the HyperTerminal folder.

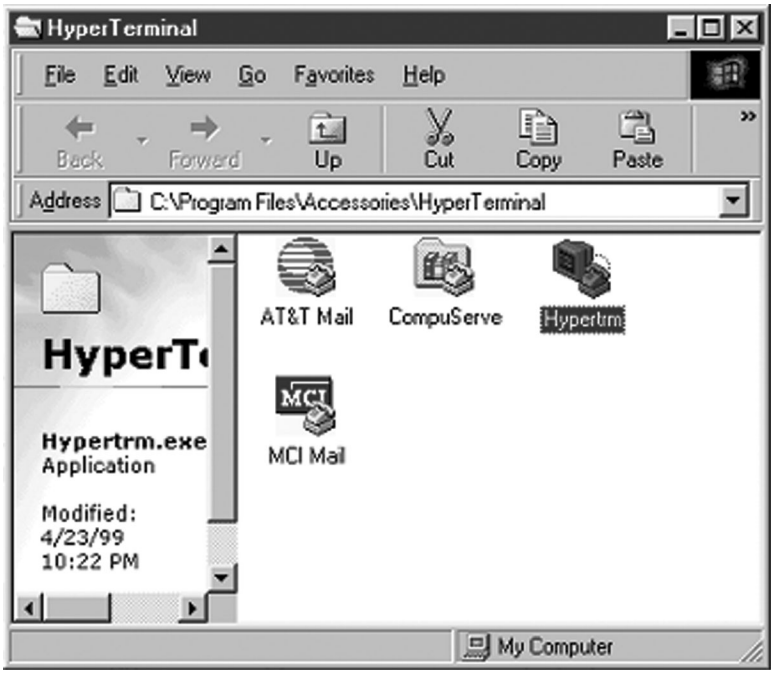


Figure 6.3: Hyper Terminal Options

5. The HyperTerminal window opens in the New Connection window.

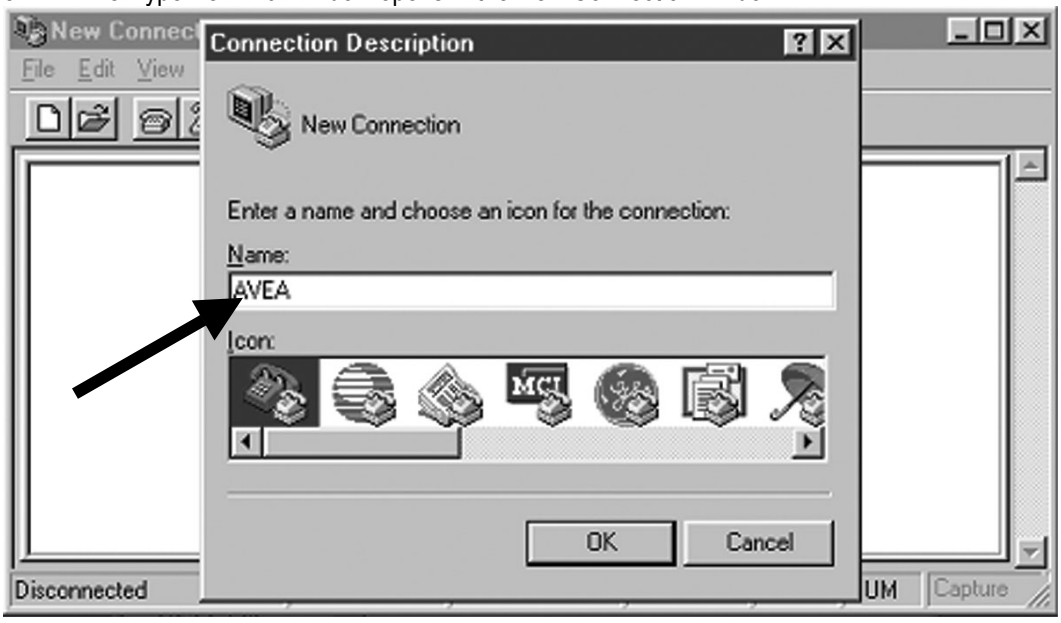


Figure 6.4: New Connection

6. Type AVEA into the Name bar and click OK. The Connectivity window opens.

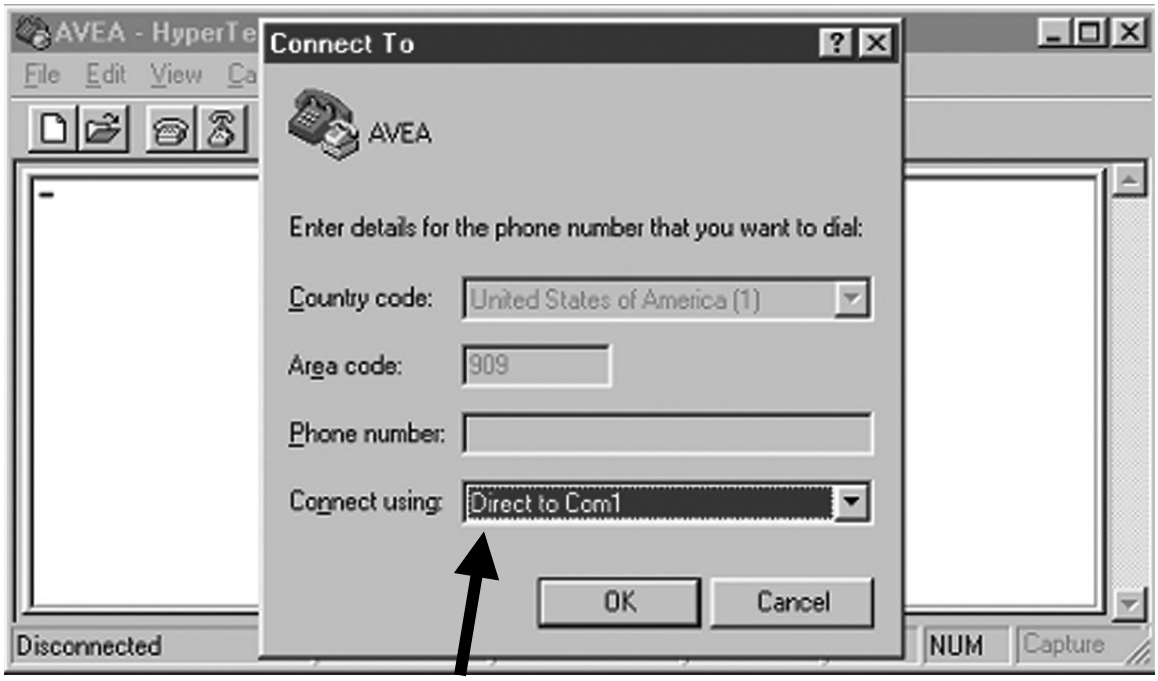


Figure 6.5: Connect Using

7. In the Connect Using bar, type Direct to Com1 (or Com2 if that is your computer connection). The Port Settings window opens

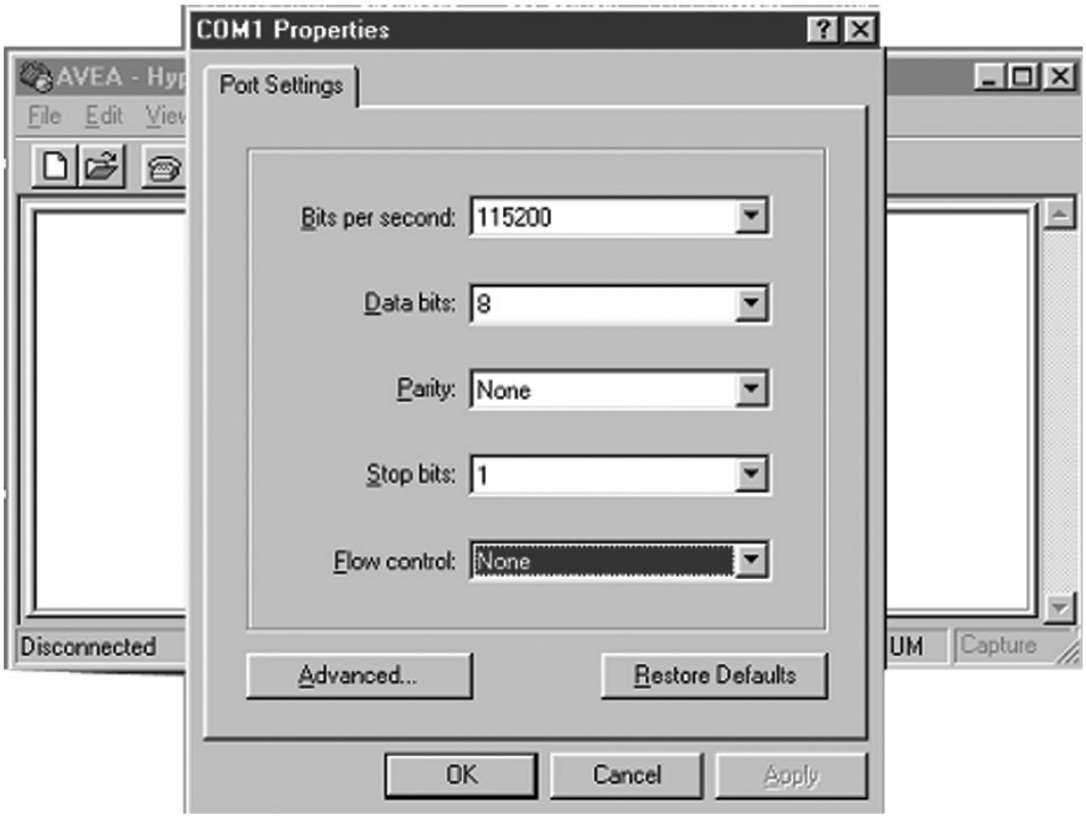


Figure 6.6: Port Settings

8. Enter the following values:
   - **Bits per second = 115200**
   - **Data bits = 8**
   - **Parity = None**
   - **Stop bits = 1**
   - **Flow control = None**
9. Click OK. The AVEA HyperTerminal window opens.

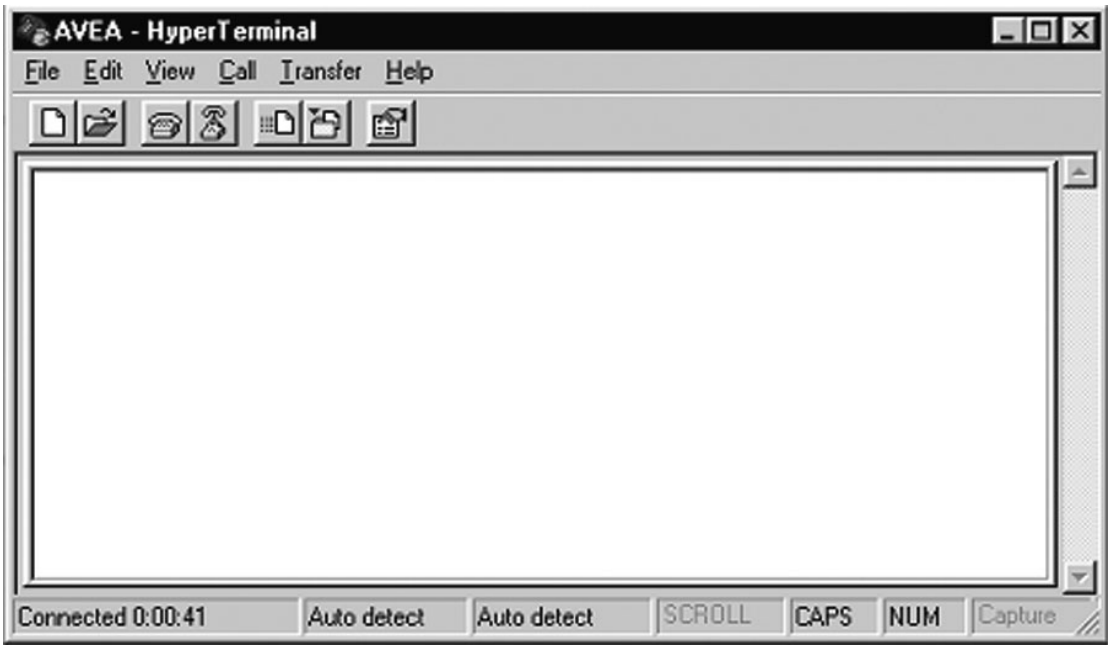


Figure 6.7: Connected

Powering up the AVEA

1. Hold down Expiratory Hold key on the front membrane panel of the AVEA during the ventilator power-up sequence until the front panel LED's light up.
2. When the LED's turn off, the Upgrade Utility banner should appear in the terminal software (HypertTerminal) window. The connection is established and ready to transfer the new software.

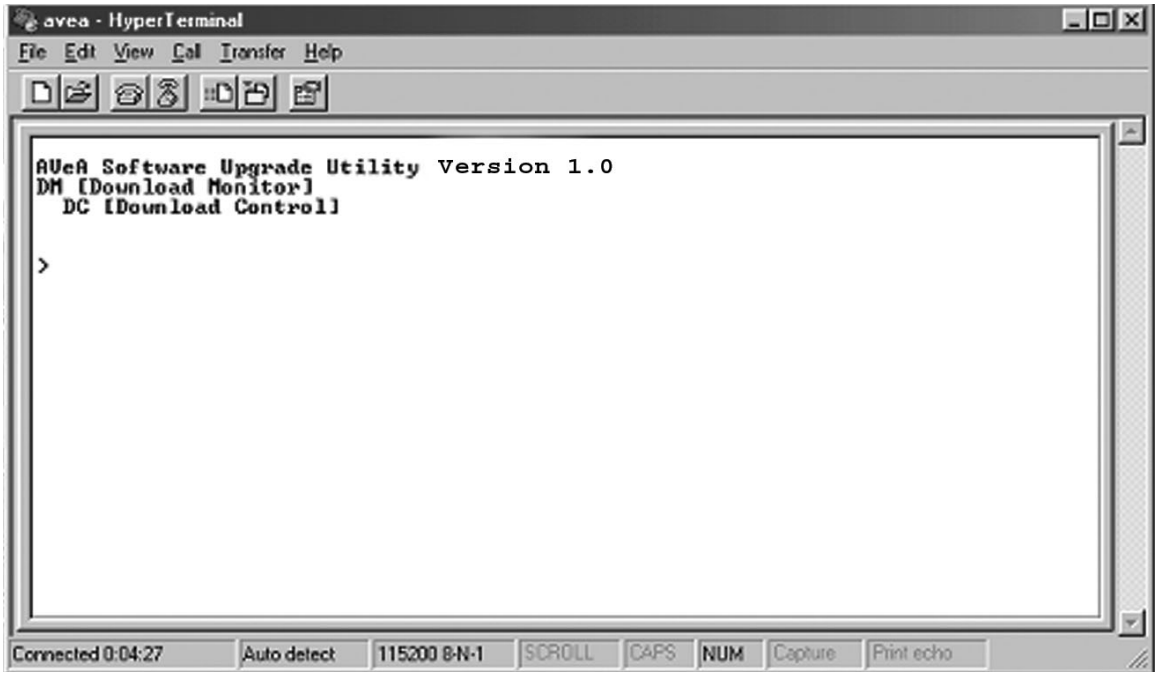


Figure 6.8: Using Hyper Terminal

3. Type **DC** at the command prompt and press ENTER to start the download for the Ventilator Control software.

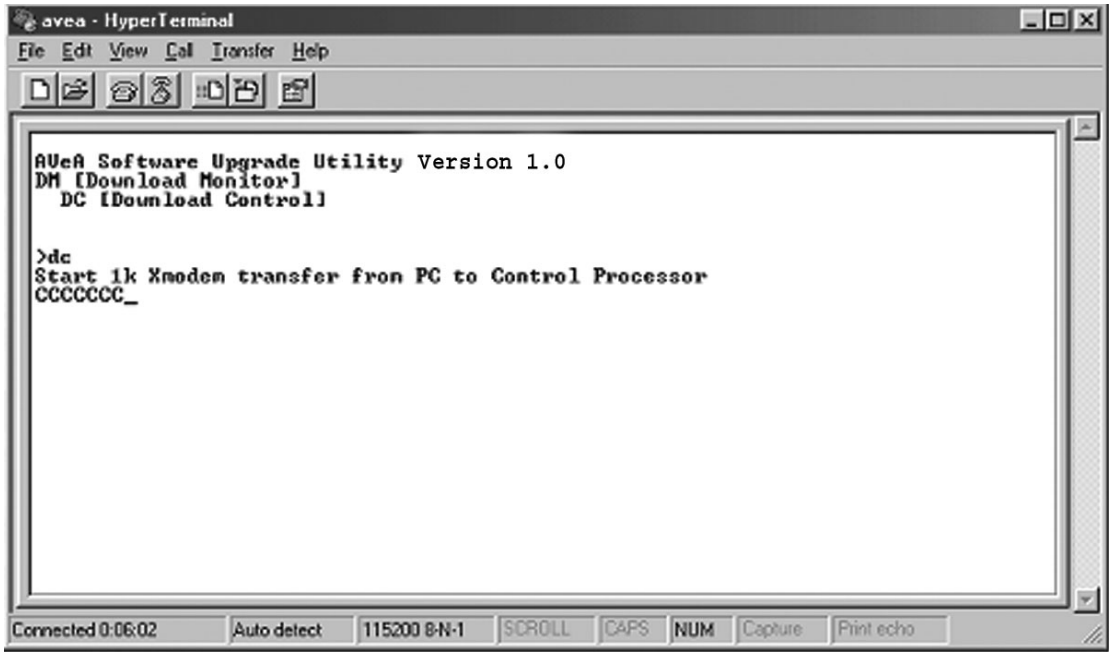


Figure 6.9: Xmodem Transfer

4. From the **Transfer** menu, select **Send File**
5. Ensure the protocol is set to "**1K XMODEM**".
6. Click **Browse** and navigate to the desktop where you saved the binary files.

7. Select the file to transfer (63568X.bin) and click **Send.** The file will begin transferring and should be monitored on the display. A confirmation will be displayed in the terminal window when the file has successfully transferred.

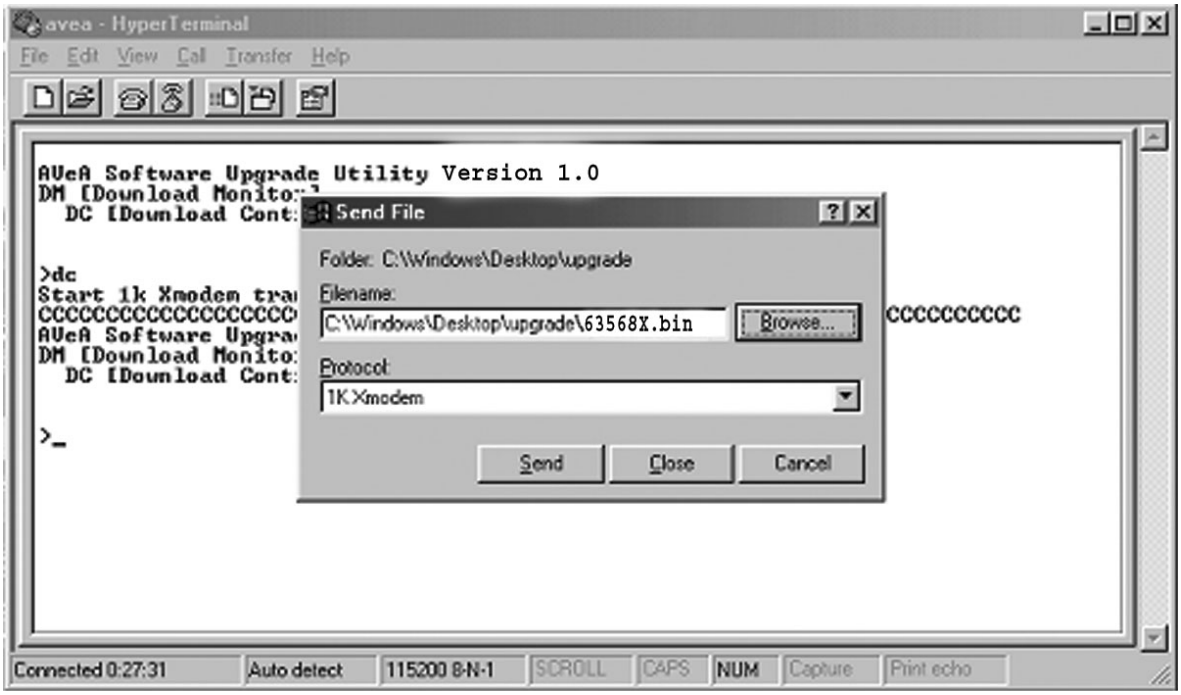


Figure 6.10: Send File

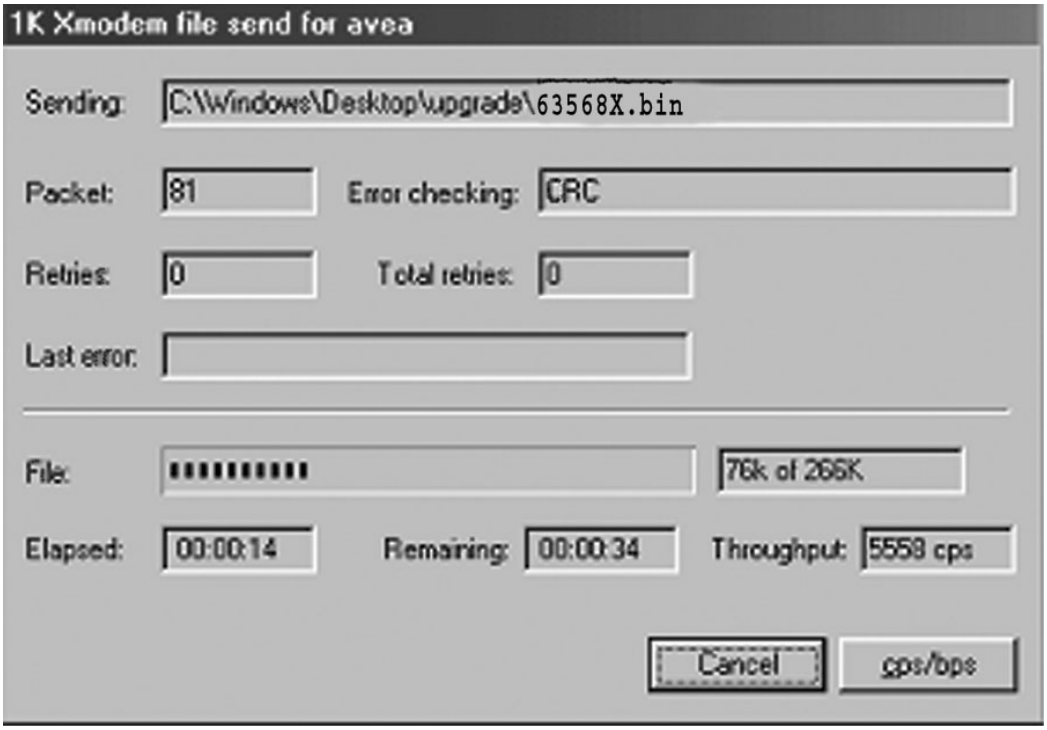


Figure 6.11: Sending a File

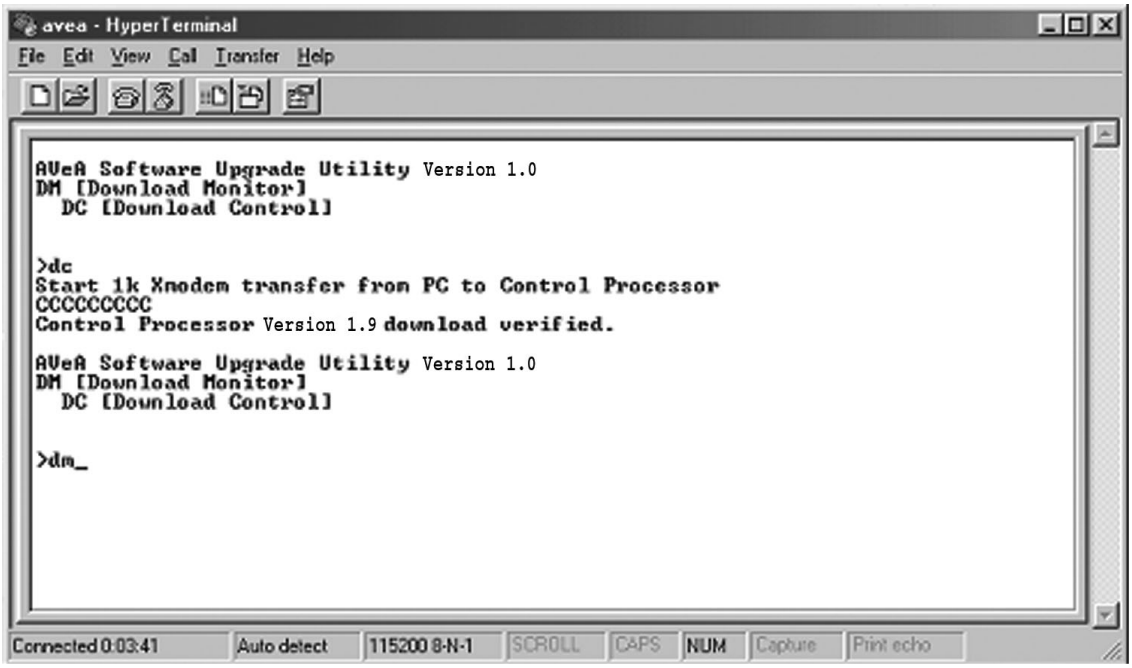


Figure 6.12: Confirmation

8. Repeat the process by typing **DM** at the command prompt and pressing RETURN to start the download for the Ventilator Monitoring software.
9. Select the SendFile command from the Transfer menu
10. Ensure the protocol is set to “1K XMODEM”.
11. Select “63569X.bin” as the file to send for the monitor program.
12. When the transfer is complete, power-down the ventilator and disconnect from PC.

Checks

When you turn the Ventilator Back “ON“ the Power On Self Tests (POST) will be performed automatically as detailed in the Operator’s Manual. When the MAIN screen displays, you will see the new version (version 1.9) displayed on the bottom of the Touch Screen.

Confirm active waveforms are displayed on the MAIN screen.

Complete the checklist attached to this procedure and return or fax to VIASYS Critical Care Division Regulatory Affairs Dept as follows:

Regulatory Affairs Dept.
VIASYS Critical Care Division
1100 Bird Center Drive
Palm Springs, CA 92262
USA
Fax number: 1 760-778-7301

Note

The User Verification Tests (i.e. The EST and Manual Alarms Checks) detailed in the operator’s manual, should be performed prior to patient connection.

Software Install Verification
AVEA Ventilators

Date:_____ Model: Comprehensive ☐ Basic ☐

UIM Serial # _____ Ventilator Serial # _____

Prior Software Version (from MAIN screen) _____

New Software version _____

Installation Verification

Monitor processor _____* verified ☐

Control processor _____* verified ☐

* *Insert version indicated by device*

Confirmation checks

Ventilator power up and POST ☐

New software version displayed ☐

Active waveforms on MAIN screen ☐

Signature: _____ Date:_____

Title: _____

SEND TO:

Regulatory Affairs Dept.

VIASYS Critical Care Division

1100 Bird Center Drive

Palm Springs, CA 92262

USA

Fax number: 1 760-778-7301

Chapter 7 Calibration

Note

Prior to calibration, warm the unit for 30 minutes.

Transducer Calibration

Current copies of these documents can be obtained from VIASYS Healthcare Technical Support as shown in Appendix A.

51000-40022 Gas Delivery Engine Schematic

51000-40697 Test Requirements, Gas Delivery Engine

51000-40843 Test Requirements, Pneumatic Module

Equipment Required.

The following list of parts & tools is recommended for calibrating the AVEA.

Table 7.1: Parts available from VIASYS Healthcare

Part Number	Description	Quantity
3001083	Catheter assy	1
51000-40094	Adult wye flow sensor	2
51000-40096	Connector, AUX port	1
52000-01193	Tube ftg, Tee 1/16 x 1/18 x 1/18 dia	3
32040	Tube ftg 1/8 to 1/16 dia reducer	2
32067	Tube ftg, tee 1/16 x 1/16 x 1/8 dia	1
52000-01205	Luer lock, male 1/16 dia	1
33980	Tubing, poly 12mm OD	1.50ft
52000-00133	Ftg, DISS, air, male ¼ NPT	1
32002	Ftg, fem R/A Elbow 12mm OD	1
52000-00132	Ftg, Oxygen, ¼ NPT x 9/16 male	2
51000-09558	Calibration syringe	1
51000-08258	O2 relay adjustment tool	1
54980-01903	Silicon tubing	10 ft

Parts not supplied by VIASYS Healthcare

Calibrated Pressure Manometer (model RT200 made by TimeMeter, recommended)
Wall or bottled gas supply of pressurized Medical Air and Oxygen.
Connector and tubing from Bicore P/N 3001042 sensor
Connector and tubing for the Wye flow sensor
Coupler, fem – fem ¼ NPT
Ftg, ¼ male NPT to 1/8 hose barb
Calibrated O2 regulator 0-50 psig
Calibrated Air regulator 0-50 psig
Wrench, 3/8 – 6pt deep socket (long 3/8 drive or short ¼ drive)
Wrench, open ended 9/16 cross foot

Calibration setup

The generic setup shown in figure 7.1 is recommended for calibrating the low pressure ports of the AVEA.

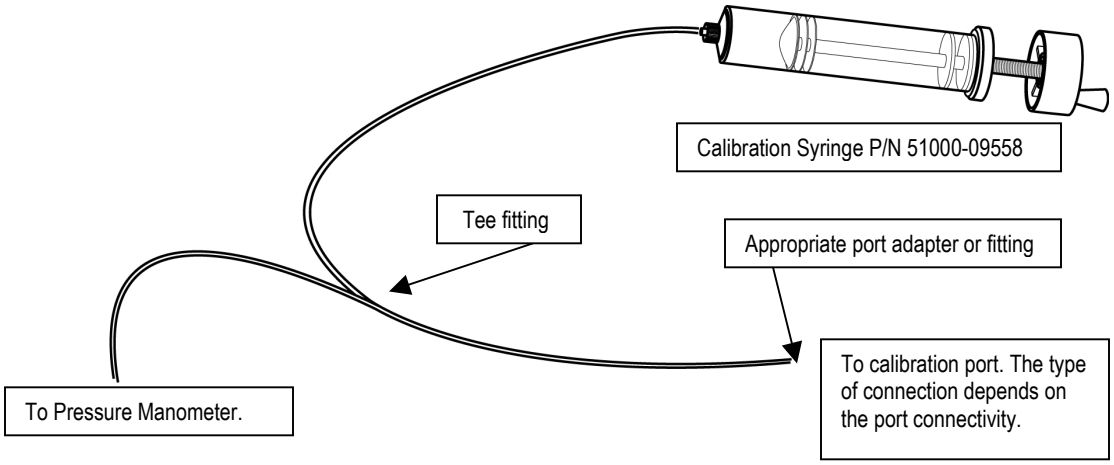

Calibration Syringe P/N 51000-09558
Tee fitting
Appropriate port adapter or fitting
To calibration port. The type of connection depends on the port connectivity.
To Pressure Manometer.

Figure 7.1 Calibration setup #1 for low pressure gases

Note

Before using any test equipment [electronic or pneumatic] for calibration procedures, the accuracy of the instruments must be verified by a testing laboratory. The laboratory master test instruments must be traceable to the NIST (National Institute of Standards Technology) or equivalent. When variances exist between the indicated and actual values, the calibration curves [provided for each instrument by the testing laboratory] must be used to establish the actual correct values. This certification procedure should be performed at least once every six months. More frequent certification may be required based on usage.

Accessing the Calibration Screen

To access the calibration:

1. Hold down the Setup key during ventilator power-up
2. When the Service Functions screen appears (see figure 7.2), press Calibrate.
3. The Calibration menu screen will appear (see figure 7.3).

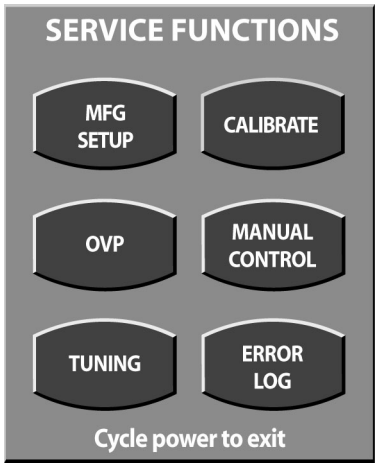


Figure 7.2 Service Functions Screen

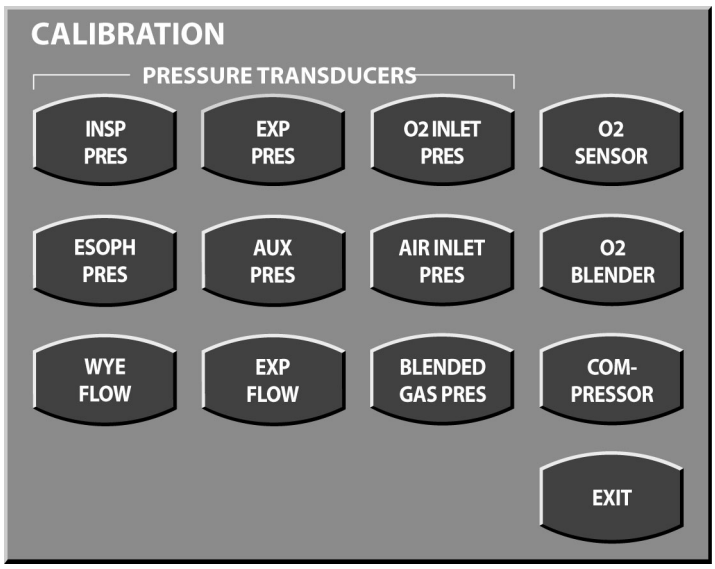


Figure 7.3 Calibration Menu Screen

Inspiratory Pressure Calibration

1. From the Calibration screen menu, press INSP PRES to access the inspiratory pressure transducer calibration screen. See figure 7.4

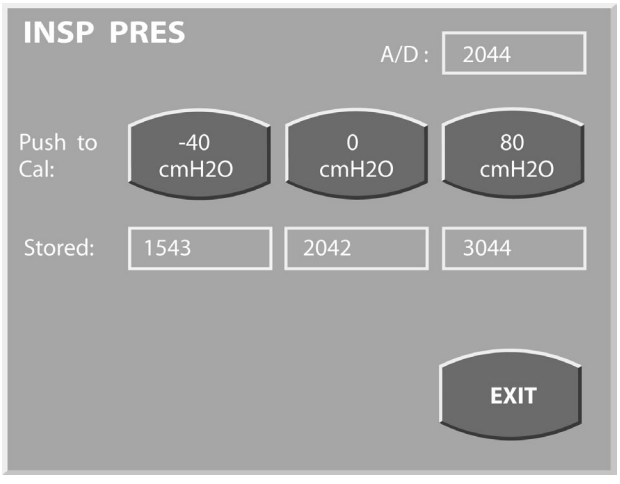


Figure 7.4 Inspiratory pressure transducer calibration screen

2. Disconnect the luer fitting and tube from port E4 on the gas delivery engine. See figure 7.5. and tubing diagram in appendix B.

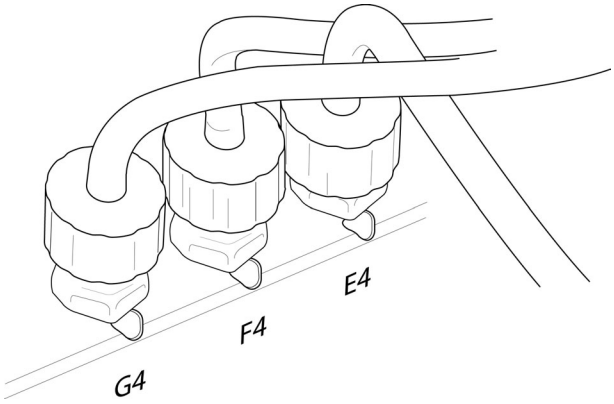


Figure 7.5 Port E4

3. With NOTHING attached to the port, press the Zero (0) calibration button on the touch screen.
4. Attach the calibration assembly shown here to port E4 on the gas delivery engine. To do this attach a length of tube with the appropriate luer fitting to the luer receptacle at E4 and connect to the calibration assembly setup using a barbed "T" fitting.
5. Using the calibration syringe P/N 51000-09558, slowly apply negative pressure to the port at E4. (Turn counter clockwise for negative pressure).
6. Refer to the reading on the calibrated Pressure Manometer (model RT200 made by TimeMeter, recommended). When the correct reading of – 40 cmsH2O is obtained, press the corresponding calibration button on the touch screen.

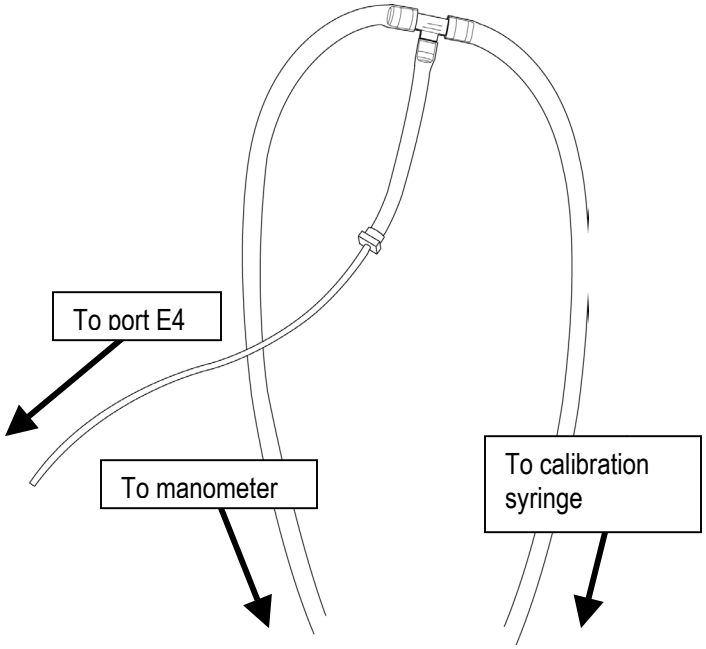


Figure 7.6

7. For positive pressure calibration, turn the syringe handle clockwise until the reading matches the 75 cmH2O number on the touch screen then press the corresponding button.
8. Press EXIT to exit.
9. Disconnect calibration set-up from E4.
10. Reconnect the luer fitting and tube into port E4 on gas delivery engine.

Wye Flow Sensor

1. From the Calibration Screen, press WYE FLOW to access the Wye Flow sensor calibration screen. See figure 7.9.
2. With no sensor attached, press the zero (0 cmH2O) button for a zero calibration value.

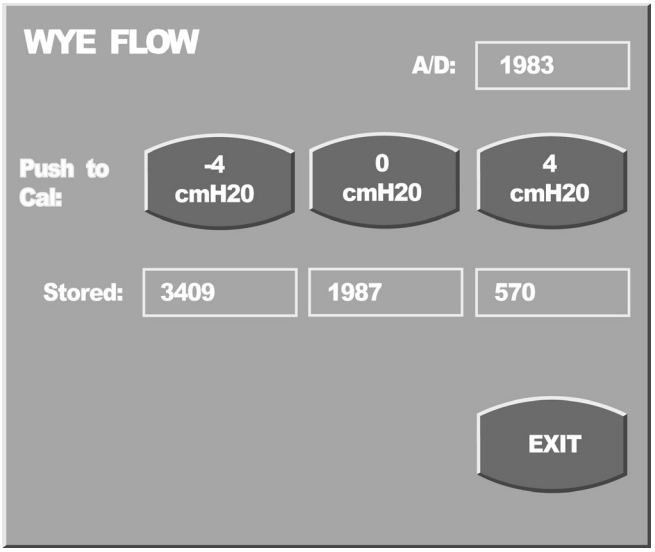


Figure 7.9 Wye flow sensor calibration screen

3. Attach the 51000-40094 sensor connector to the AVEA. Attach the *blue tube only* of the Wye flow sensor to the basic calibration tubing assembly using a barbed fitting. Leave the clear tube unattached as shown here
4. Turn the calibration syringe slowly counter clockwise for a negative pressure of only -4cmsH2O for the negative calibration value and plus 4 cmH2O for the positive value. Press the appropriate touch screen button when each value is reached to capture and store the value.
5. Exit Wye Flow Sensor screen.

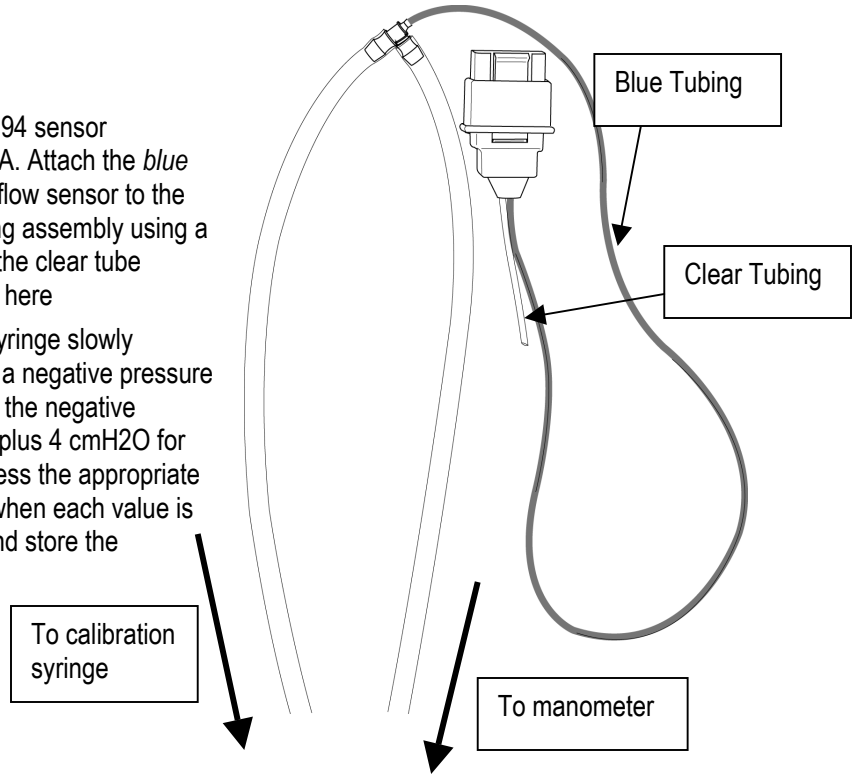


Figure 7.10

WARNING

DO NOT APPLY MORE THAN 10cmH2O TO THIS PORT. Excessive pressure will damage the AVEA. If this occurs immediately contact Technical Support for instructions.

Expiratory Pressure

1. From the Calibration Screen, press EXP PRES to access the calibration screen. See figure 7.13.
2. Remove internal expiratory flow sensor.
3. With no sensor attached, press the zero (0 cmH2O) button for a zero calibration value.

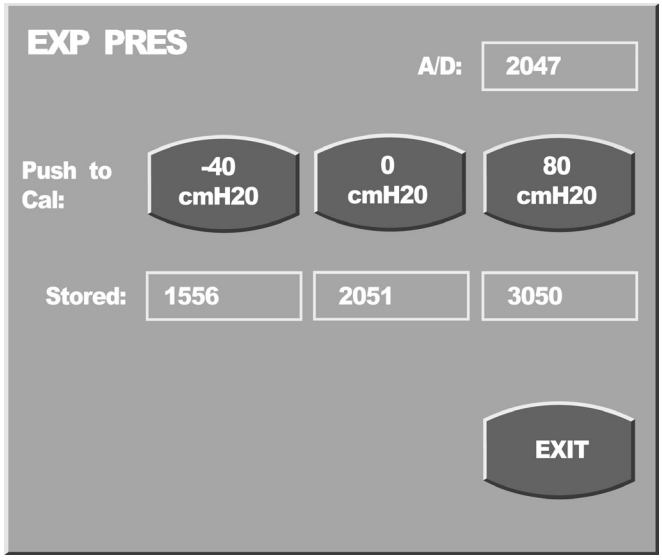


Figure 7.13 Expiratory Pressure calibration screen

4. Attach *both tubes* (blue & clear) of the Expiratory Sensor P/N 51000-40094 to the basic calibration tubing assembly using a barbed "T" fitting as shown here.

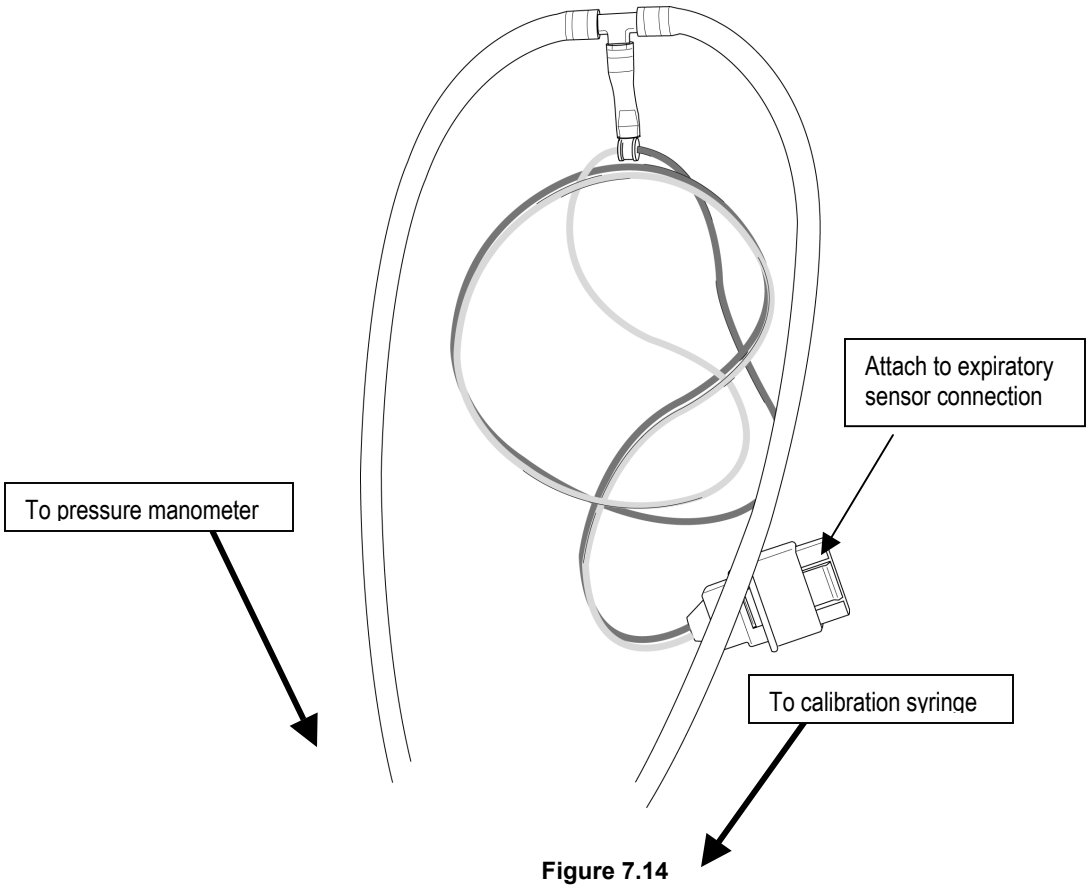


Figure 7.14

5. Connect the tubing assembly to the internal expiratory sensor port. See figure 7.15 for the sensor connector location.

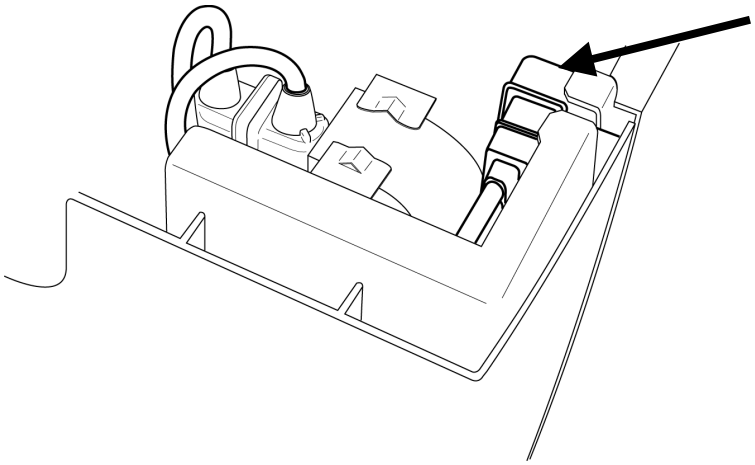


Figure 7.15 Expiratory Sensor connector location

CAUTION

The expiratory sensor connector has a locking sleeve. Be sure to fully retract the sleeve before attempting to attach the connector. Failure to do so could damage the connector.

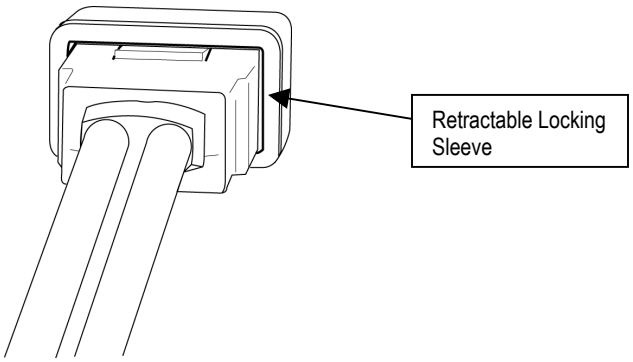


Figure 7.16 Expiratory Sensor Connector

6. Turn the calibration syringe slowly counter clockwise for a negative pressure of -40cmsH2O to establish the negative calibration value and plus 75 cmH2O to establish the positive value. Press the appropriate touch screen button when each value is reached to capture and store the calibration.
7. Press EXIT to exit

Expiratory Flow

1. Press the EXP FLOW touch screen button to access the screen, see figure 7.17.
2. With nothing attached to the ventilator, press the 0 cmH2O touch screen button.

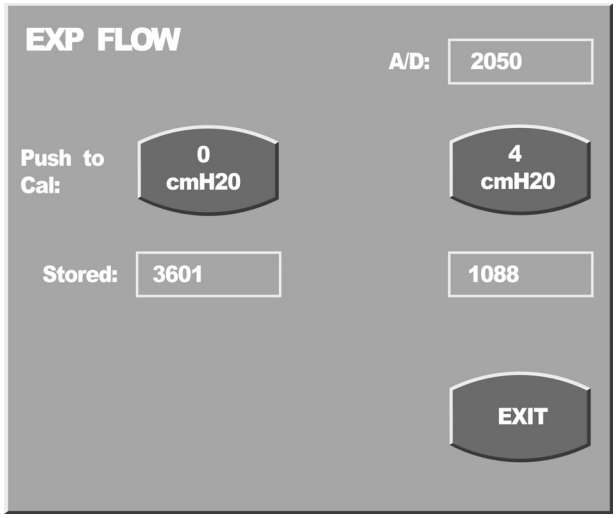


Figure 7.17 Expiratory Flow Calibration Screen

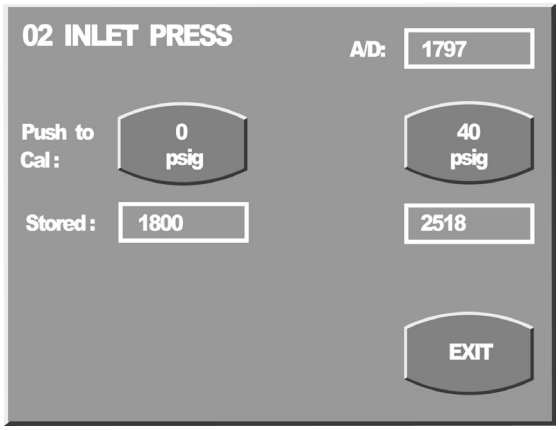
3. Using the same sensor connector and tubing setup as the wye flow calibration, carefully attach the locking sleeved connector to the expiratory flow port as shown in figure 4.11.
4. Turning the calibration syringe clockwise, apply 4 cmH2O pos pressure and press the positive pressure touch screen button.

WARNING

Apply NO MORE THAN 10 cmH2O to the port when calibrating this value. Doing so could cause damage to the AVEA. If this occurs immediately contact Technical Support for instructions.

5. Press EXIT to exit.

O2 inlet pressure



1. Press O2 INLET PRES from the Calibration screen to access the O2 Inlet pressure calibration screen.
2. With nothing attached to the instrument, press the 0 psig touch screen button.

Figure 7.18 O2 Inlet Pressure calibration screen

3. Use a calibrated 0-150 psi regulator and a wall or cylinder supply of medical oxygen.
4. Using a "Y" adapter (see figure 7.19), attach the "Y" adapter shown here to the regulator. A

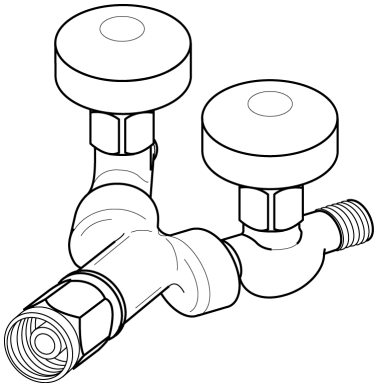


Figure 7.19 "Y" high pressure DISS 1290 adapter

5. Attach one arm of the tubing to the manometer and connect the other (with the correct DISS fitting) to the high pressure O2 inlet on the rear of the instrument shown in figure 7.20.

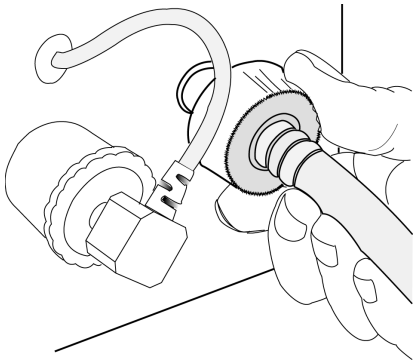


Figure 7.20 O2 hose connection

5. Apply 40psig (2.76 bar) of pressure & press the corresponding touch screen button to calibrate.

Air inlet Pressure

Press the AIR INLET PRES touch screen button from the calibration screen to access the Air Inlet Pressure calibration screen as shown in figure 7.21.

With nothing connected to the air/blended gas inlet port on the rear of the ventilator, press the 0 psig touch screen button.

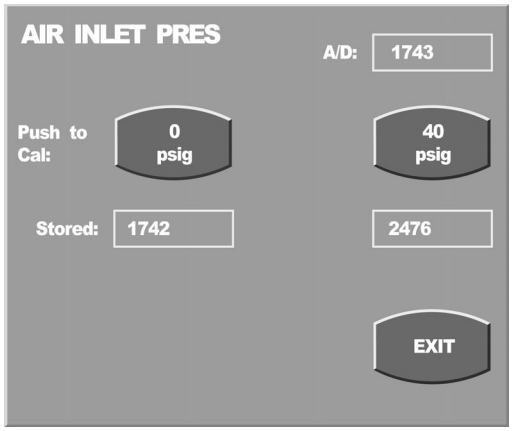


Figure 7.21 Air Inlet Calibration screen

Connect, a wall or cylinder supply of medical grade air through a calibrated 0-150 psi regulator and "Y" adapter P/N to a manometer and to the high pressure air/heliox inlet on the rear of the ventilator.

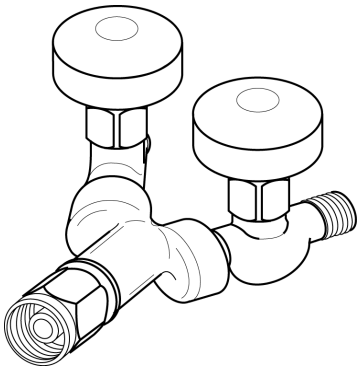
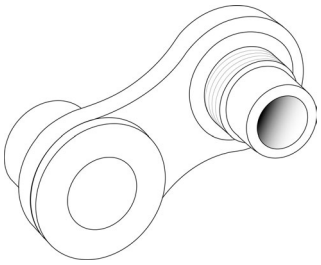


Figure 7.22 "Y" adapter



Attach the air inlet smart connector to the port on the rear of the ventilator.

Figure 7.23 "Smart" Connector

Attach the hose from the calibrated regulator on the medical grade air source to the smart connector port and apply 40psi pressure per the in-line manometer. When the correct reading is obtained, press the 40 psig touch screen button on the Air Inlet calibration screen.

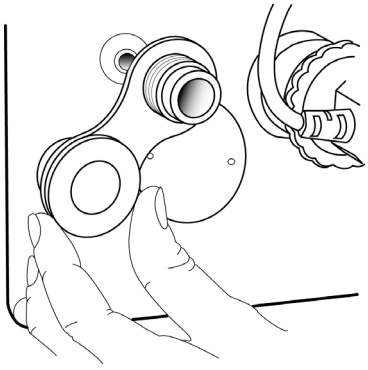


Figure 7.24 Attaching the smart connector

Blended Gas Pressure

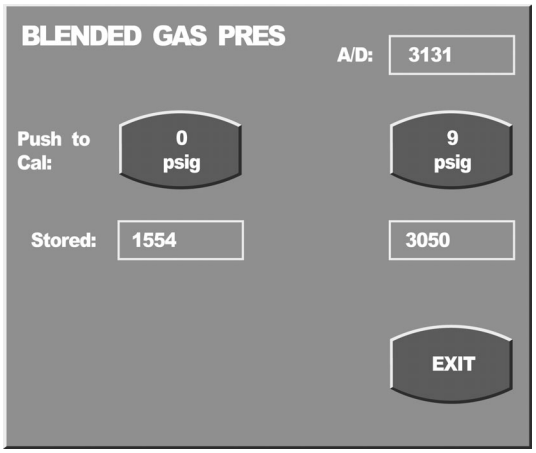


Figure 7.25 Blended Gas Pressure Screen

1. Press the BLENDED GAS PRES touch screen button from the Calibration screen to access the blended gas pressure calibration screen.
2. Cut cable tie. Remove metal hose stabilizer.
3. Disconnect compressor output hose.
4. Press 0 psig with nothing connected to the ventilator. Disconnect the input of the accumulator at port C2 where connects to the blender manifold. See figure 7.26.

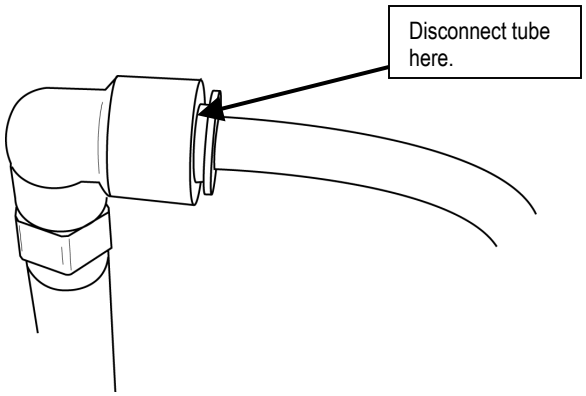
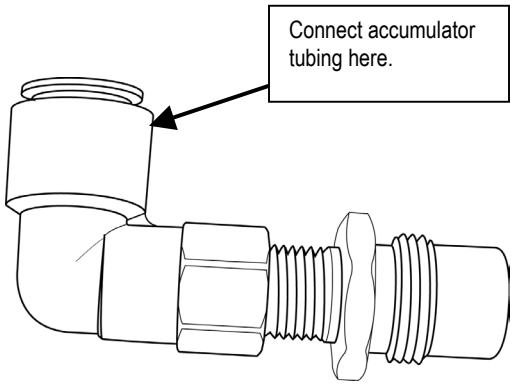


Figure 7.26 Port C2 connection



5. Use adapter (see figure 7.26) to attach calibration tubing assembly #1 to the accumulator input tubing. Attach also to a calibrated 0-150psi regulator connected to the high pressure gas source & to a manometer.

Figure 7.27 Adapter for accumulator tubing.

6. Apply 9 psig from the regulator (connected to wall or bottled gas). When the correct reading is obtained on the manometer, press the 9 psig touch screen button.

7. Reconnect and reassemble compressor output hose to blender manifold. Attach metal hose stabilizer. Replace cable tie.
8. Press EXIT to exit.

O2 sensor

Press the O2 SENSOR touch screen button on the Calibration Screen menu to bring up the O2 Sensor calibration screen.

With nothing attached to the ventilator, press the 21% touch screen button.

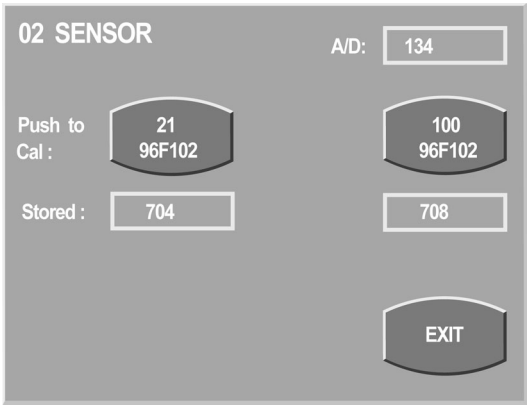


Figure 7.28 O2 Sensor Calibration Screen

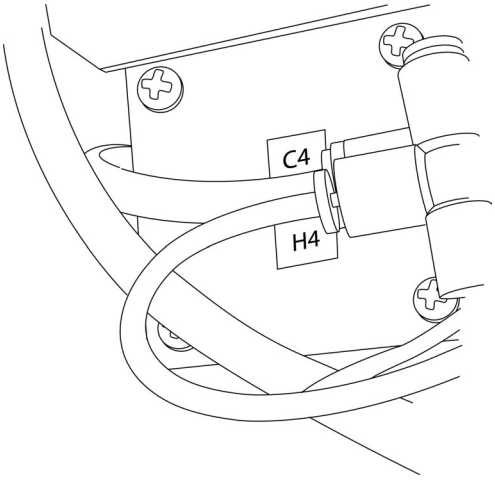


Figure 7.29

Using a "Y" adapter, connect a wall or bottled medical oxygen supply via a calibrated 0-150 psig regulator to the calibration tubing assembly shown here. Connect to port H4 on the Gas Engine. Connect the other leg of the "Y" to a manometer

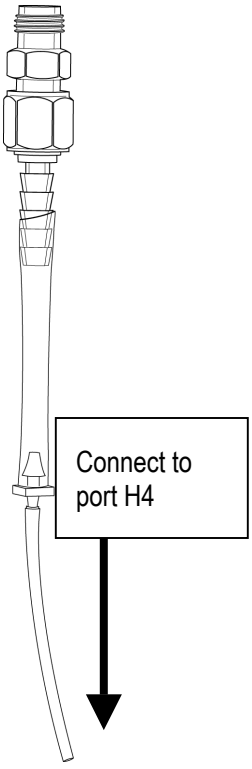


Figure 7.30

Apply 9 psig of 100% medical oxygen to port H4, wait until the manometer pressure reading stabilizes then press the 100% touch screen button

O2 Blender and Compressor Calibration

Calibration of the O2 blender and the Compressor is done at the VIASYS Healthcare factory.

Contact your VIASYS Healthcare Critical Care Division representative as shown in Appendix A.

Chapter 8 Preventative Maintenance

Routine Maintenance Procedures

The following parts are typically replaced on an annual basis:

- Air inlet filter
- Oxygen inlet filter
- Compressor inlet filter
- Compressor outlet filter
- Exhalation Diaphragm

The following service procedures will be performed at this time:

1. Remove and replace (items described above)
2. Calibrate the following pressure Transducers (9 total)
    - Air (Blended gas)
    - O2
    - Blended Gas
    - Expiratory Flow
    - Inspiratory Flow
    - Exhaled flow delta
    - Wye flow delta
    - Auxiliary
    - Esophageal
3. Check Compressor output.
4. Perform OVP (Operational Verification Procedure) and manual alarms checks.

Replacing the O2 and Air/Heliox filters.

You can access both these gas filters from the rear panel of the ventilator. See figure 8.1 below.

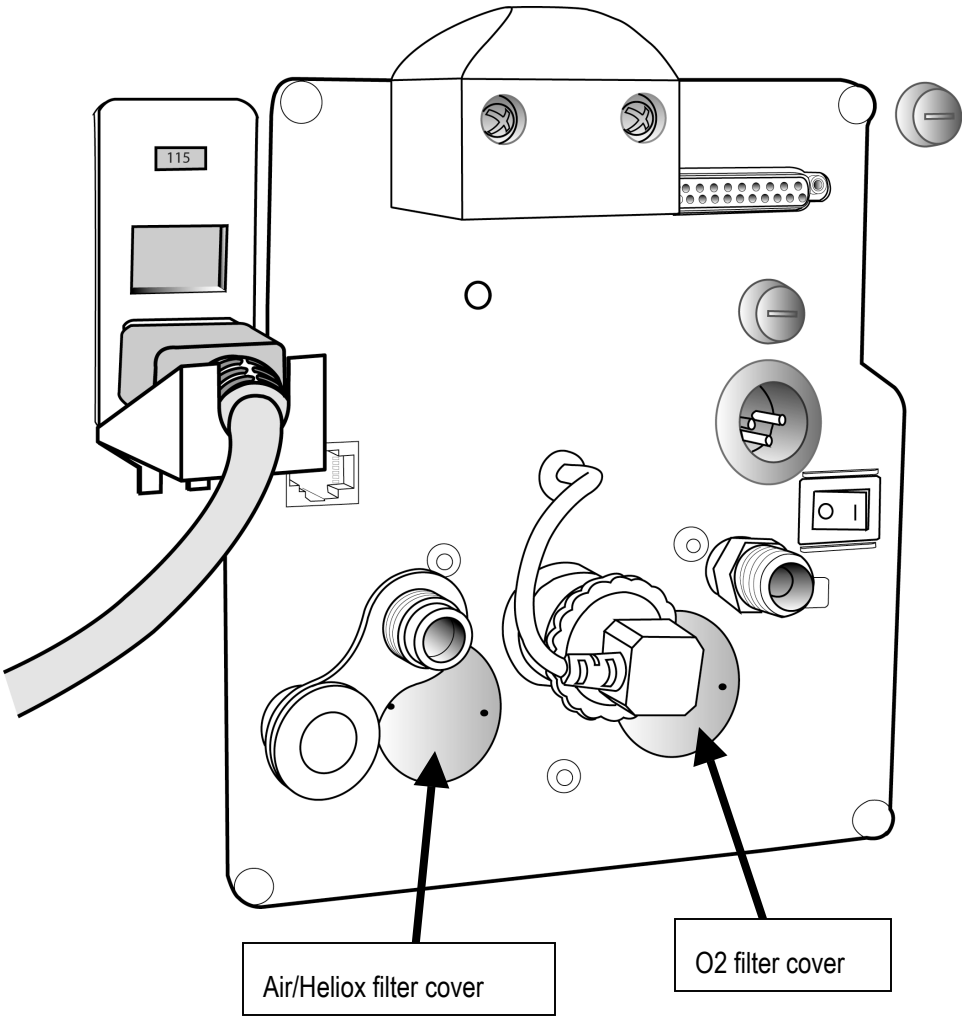


Figure 8.1 Rear panel

To remove the O2 & Air/Heliox filter covers, you will need tool number TL-109, available from Viasys Healthcare Technical Support .

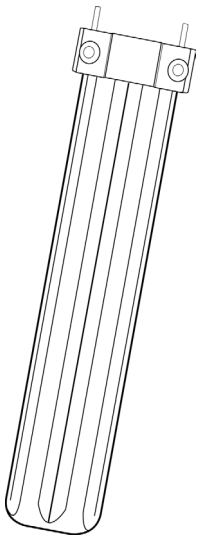


Figure 8.2 Tool TL-109

Using tool number TL-109, unscrew the filter covers to expose the filters.

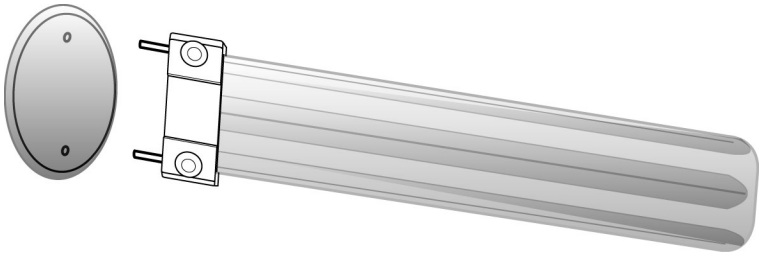
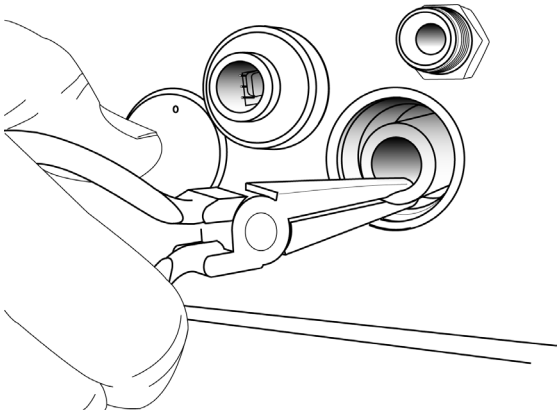
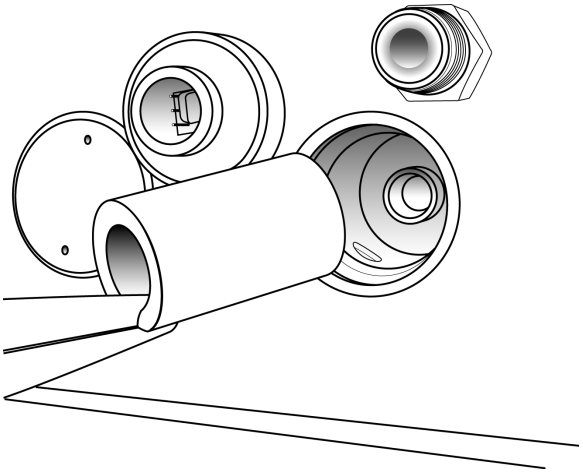


Figure 8.3 Removing the filter covers



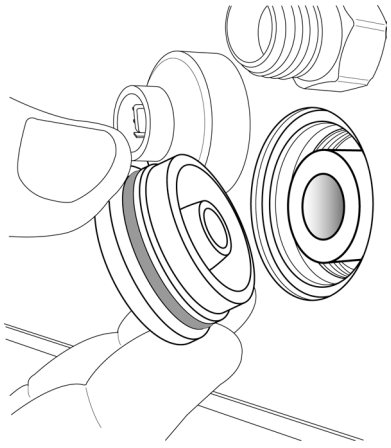
Using needle nosed pliers, grasp the filter firmly and pull straight out from the filter port.

Figure 8.4 Removing the filter



Replace the old filters with new ones (Balston P/N 050-05) taking care to seat the filter over the filter retainer inside the port as you insert each one.

Figure 8.5 Replacing the filter



Align the filter retainer in the center inside the filter as you replace the cover.

Figure 8.6 replacing the filter cover

Replacing the Compressor Inlet & Outlet filters

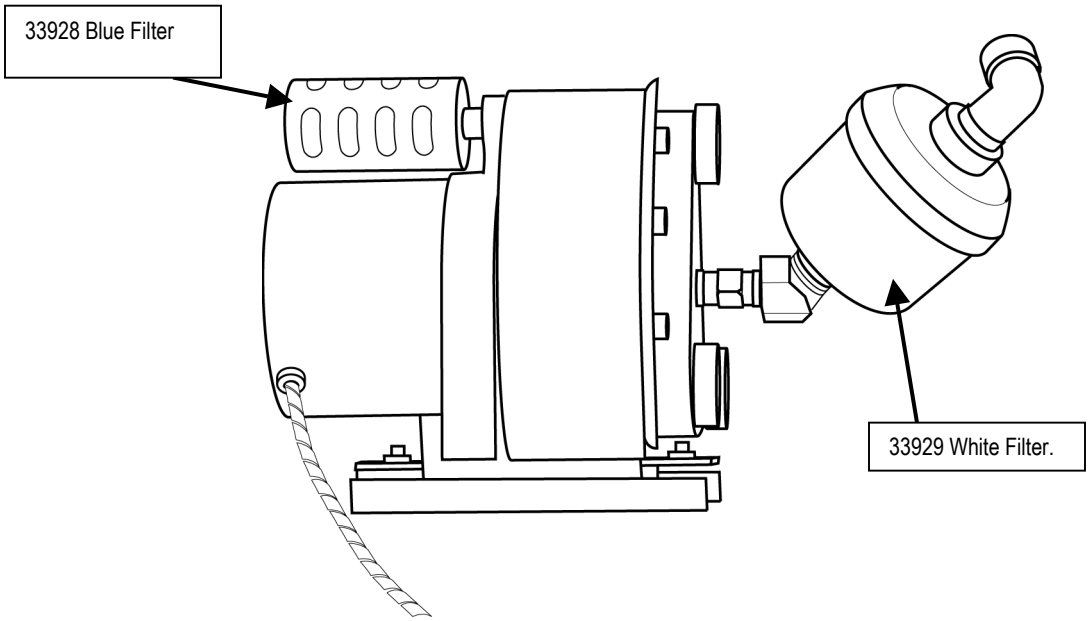


Figure 8.7 Compressor and filters

Disassemble the ventilator as shown in Chapter 4 to access the Compressor filters.

Both the inlet and the outlet filters unscrew as complete assemblies for replacement. Use only the part numbers shown above available from VIASYS Healthcare Critical Care division.

Replacing the Exhalation Diaphragm

To replace the exhalation valve membrane, first remove the following:

- The UIM
- The top cover
- The exhalation filter/water trap assembly
- The exhalation assembly (corner) cover.

Once the top cover and the exhalation cover have been removed, the exhalation assembly should be accessible (see figure 8.8)

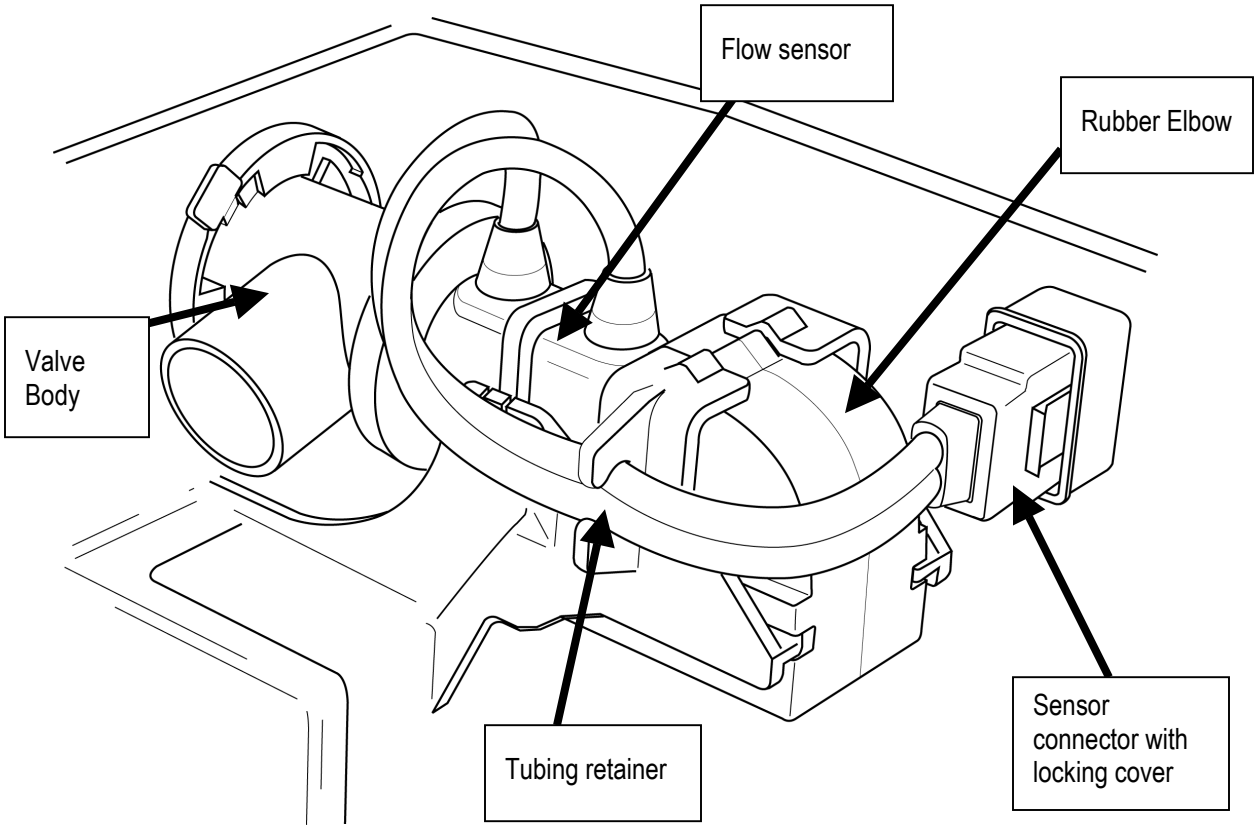


Figure 8.8 Exhalation assembly

Unplug the sensor connector from the receptacle taking care to retract the locking shroud as you do so.

Loosen the tubing form the tubing retainer.

Grasp the rubber elbow and pull firmly out towards the front of the AVEA. This will expose the flow sensor. Set the rubber elbow aside.

Gently free the flow sensor from the exhalation valve body and pull out towards the front of the AVEA. This will leave the valve body in place.

To remove the valve body, press down on the lever shown in figure 8.9, turn the valve body counter clockwise until the fins of the locking mechanism release and pull out. This will expose the membrane.

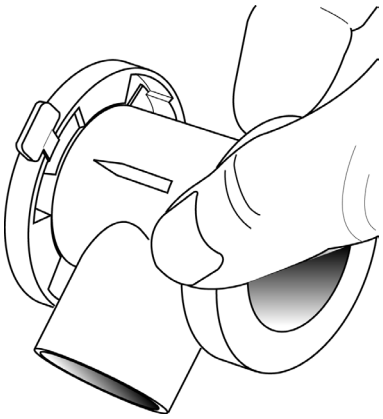


Figure 8.9 Disengage valve body

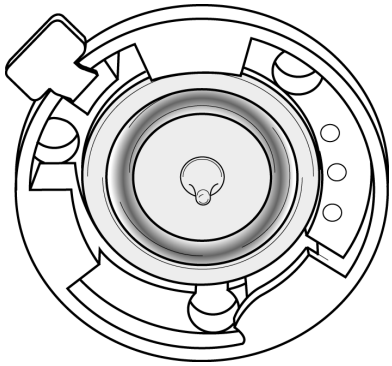
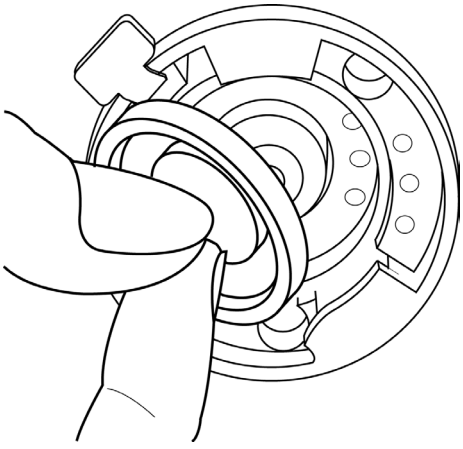


Figure 8.10 Membrane seated in the valve body.



To remove the membrane, grasp the nipple and gently pull away from the valve body.

Figure 8.11 Removing the membrane

Replace the membrane and press gently into the valve body making sure that the edges are well seated .

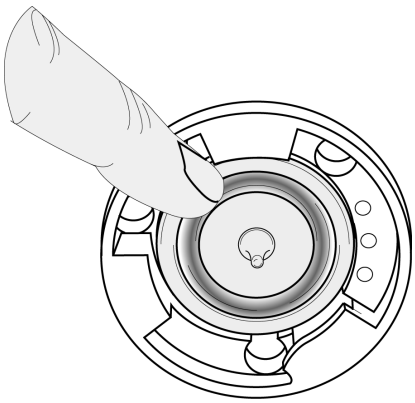


Figure 8.12 Seating the new membrane

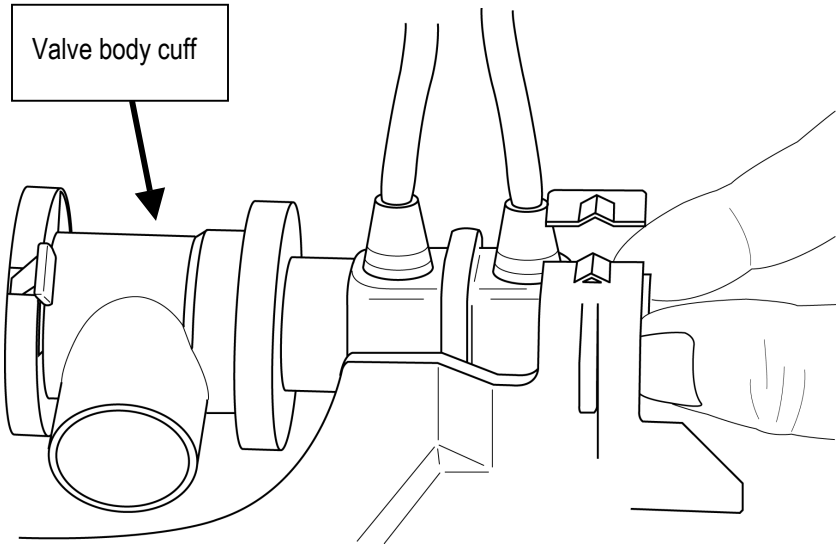


Figure 8.13 Insert the flow sensor

Grasp the flow sensor by the smaller diameter orifice and insert into the cuff on the valve body.

Push the rubber elbow onto the smaller end of the flow sensor taking care to align the groove on each side with the corresponding rail of the molded holder.

When the elbow is correctly installed, the molded protrusion on the top lines up with the protrusions on each side of the holder.

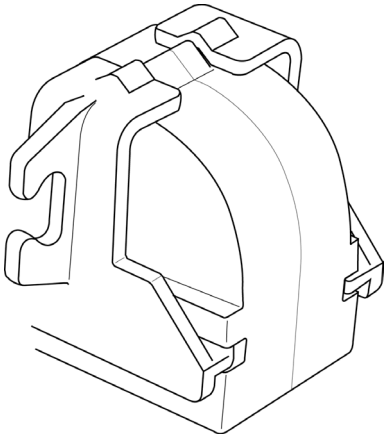


Figure 8.14 Align rubber elbow.

Reconnect the sensor and insert the two tubes into the tubing retainer.

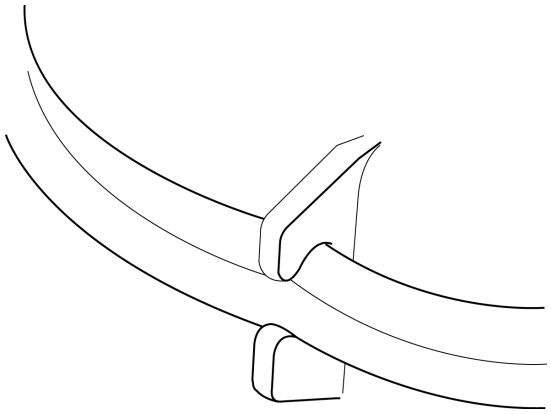


Figure 8.15

Replace the exhalation assembly cover and top cover. Replace & reconnect the UIM.

Run OVP tests after any part replacement.

Chapter 9 Troubleshooting

This section describes how to troubleshoot the ventilator if:

- The ventilator does not turn on properly.
- A Vent Inop occurs when you turn on the ventilator.
- An Operational Verification Test fails.
- A malfunction occurs.

If The Ventilator Does not Turn ON

If you turn the power switch ON and the ON indicator does not illuminate, perform the troubleshooting procedures given in Table 5.1.

Table 9.1: Troubleshooting Power-Up Problems

PROBLEM	POSSIBLE CAUSE	ACTION
Ventilator plugged into an AC source but does not power up.	No power at AC outlet, or the AC/DC select switch is in the ALT PWR SOURCE position, or the AC Line Voltage switch is set to the wrong voltage.	Try connecting to a known good AC power source. Make sure the AC/DC switch is in the AC position. Make sure, the voltage setting of the ventilator matches the voltage of your power source. Check the fuse assembly if the ventilator still does not power up, Contact your Bird Products Certified Service Technician. Check the DC voltage output supply from transformer at J9. Check DC voltage at J3. Black is ground. Red is 5 volts DC and Yellow is 14.7 to 20 DC. If voltage is not present, replace Power Supply PCB.
Ventilator attached to alternate external DC power source but does not power up.	If the external source is a battery, the battery may not be charged, or the AC/DC select switch may be in the AC position.	Plug the ventilator into a known good AC source, or to a known good battery and see if it powers up. If using a 12VDC power source, set the AC/DC select switch to the ALT PWR SOURCE position. Check the fuse assembly. If the ventilator still does not power up, contact your Bird Products Certified Service Technician. Check DC voltage at J3. Black is ground. Red is 5 volts DC and Yellow is 14.7 to 20 DC. If voltage is not present, replace Power Supply PCB.

If a Vent Inop alarm occurs.

Remove the ventilator from service and contact VIASYS Healthcare Technical Support.

You may be asked to check the error log. To do this, power up the ventilator with the SETUP key depressed. When the SERVICE FUNCTIONS screen appears, press ERROR LOG. The following screen appears listing all error codes chronologically with the latest occurring at the top.

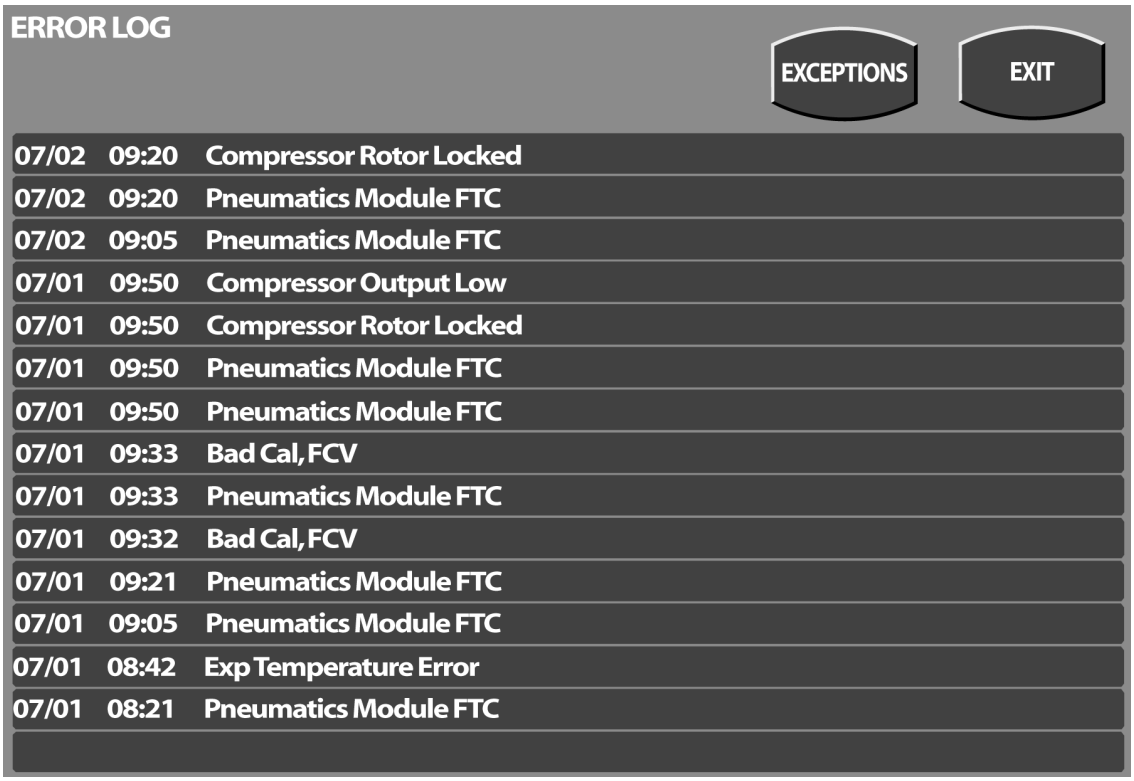

ERROR LOG
EXCEPTIONS
EXIT
07/02 09:20 Compressor Rotor Locked
07/02 09:20 Pneumatics Module FTC
07/02 09:05 Pneumatics Module FTC
07/01 09:50 Compressor Output Low
07/01 09:50 Compressor Rotor Locked
07/01 09:50 Pneumatics Module FTC
07/01 09:50 Pneumatics Module FTC
07/01 09:33 Bad Cal, FCV
07/01 09:33 Pneumatics Module FTC
07/01 09:32 Bad Cal, FCV
07/01 09:21 Pneumatics Module FTC
07/01 09:05 Pneumatics Module FTC
07/01 08:42 Exp Temperature Error
07/01 08:21 Pneumatics Module FTC

Figure 9.1 Error log

If there is more than one page of error codes, you can scroll through them using the Data Dial. In this way, you can print a page-by page record of the codes for reference or reporting purposes.

When you have captured this information, press the Exceptions key. The EXCEPTION LOG appears.

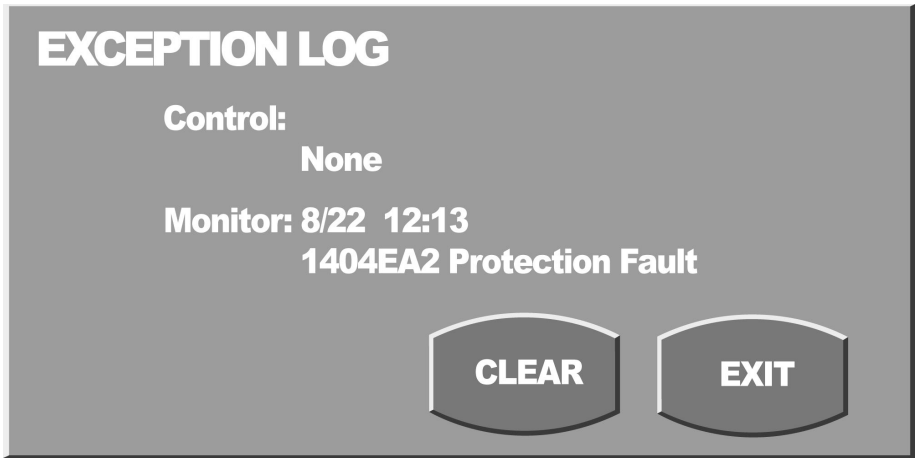


Figure 9.2 Exception Log

In the event of a fatal error, in either the Control or the Monitor processor, the date, time and address will be recorded here. You can print this and/or record the information for reporting purposes.

When you have captured the Exception log information, press Exit. DO NOT press Clear at this time, you may need to refer to this information again, or the factory technician may need to do so if the unit is returned for repair.

List of Possible Error Codes

Abbreviations:

FTC: Fail-to-cycle

IFS: Inspiratory Flow Sensor

FCV: Flow Control Valve

EFS: Expiratory Flow Sensor

PT: Pressure Transducer

Sup: Supply

BG: Blended Gas

WFS: Wye Flow Sensor

HWFS: Hot Wire Flow Sensor

Messages:

Pneumatics Module FTC
HSSC Comm Fault
IFS Voltage Fault
TCA A/D Ref Fault
IFS A/D Ref Fault
Compressor Rotor Locked
Compressor Output Low
FCV Overcurrent Fault
DPRAM Comm Error, Mntr
DPRAM Comm Error, Ctrl
Data Error, TCA
Bad Cal, EFS PT
Bad Cal, Insp PT
Bad Cal, Exp PT
Data Error, Blender
Bad Cal, Blender
Data Error, Air Sup PT
Bad Cal, Air Sup PT
Data Error, O2 Sup PT
Bad Cal, O2 Sup PT
Data Error, BG PT
Bad Cal, BG PT
Device Not Found, IFS
Header Error, IFS
Data Error, IFS
Bad ID, IFS
Bad Cal, IFS
Device Not Found, EFS
Header Error, EFS
Data Error, EFS
Bad ID, EFS
Bad Cal, EFS
Bad Cal, FCV
Bad Model Number
Bad Cal, FiO2
Header Error, Compressor
Data Error, Compressor
Bad Cal, Compressor
Invalid Feature, EPM
Header Error, EPM
Data Error, EPM
Bad Cal, WFS PT
Bad Cal, Esoph PT
Bad Cal, Aux PT
Bad Sensor Type, HWFS
Header Error, HWFS
Data Error, HWFS
Bad ID, HWFS
Bad Cal, HWFS
Header Error, WFS
Data Error, WFS
Bad ID, WFS
Bad Cal, WFS
Settings Lost
Config Lost
Insp Temperature Error

Exp Temperature Error
Bad ID, Ctrl PCB
Header Error, Ctrl PCB
Bad ID, TCA
Header Error, TCA
Bad ID, Power PCB
Header Error, Power PCB
Bad ID, Blender
Header Error, Blender
Bad ID, Air Supply PT
Header Error, Air Sup PT
Bad ID, O2 Supply PT
Header Error, O2 Sup PT
Bad ID, BG PT
Bad Header, BG PT
Trend Data Lost
Event Log Data Lost
Compressor Runtime Data Error

Table 9.2: AVEA Mechanical Troubleshooting

! Check error log (and exceptions) with any "Device Error" message on screen

! Remove ventilator from patient with any potential problem

1. Battery/Power Supply

* Insure unit is plugged in between patient use.

* Refer to service manual for proper battery discharge/charging procedures.

* Check all cables/connections and voltages before replacing parts..

Symptom	Problem	Solution(s)
Unit will not power up	Blown/incorrect/missing A/C fuse(s) Loose Internal Connection(s) Bad Power Switch Bad Power supply Bad Power Driver PCB UIM problem	Check/replace A/C fuses Check all connections from wall A/C through Power Supply Replace Power Switch Replace Power supply Replace Power Driver PCB (GDE) Check UIM cable. Refer to "UIM/Control" section
No battery indication (LED)	Excessively discharged battery state Blown/Missing batt fuse Loose connections Bad Battery PCB Bad LED indicator panel Bad battery Transition Board fault	Charge properly-refer to service manual Check/replace fuse Check connections Replace Battery PCB Replace LED indicator panel Check/replace battery Replace Transition Board
Will not charge past yellow	Excessively discharged battery state Loose connections Bad Battery PCB Bad battery Bad Power Driver PCB	Charge properly-refer to service manual Check connections Replace Battery PCB Check/replace battery Replace Power Driver PCB (GDE)
Decreased run time on battery (internal/external)	Excessively discharged battery state Loose connections Bad Battery PCB Bad battery Bad Power Driver PCB	Charge properly-refer to service manual Check connections Replace Battery PCB Check/replace battery Replace Power Driver PCB (GDE)
Unit wont run on battery (internal/external)	Blown/missing battery fuse Loose connections Bad battery Bad Power PCB	Check/replace fuse Check connections Check/replace battery Replace Power PCB (GDE)

Symptom	Problem	Solution(s)
Unit does not run on A/C	Wiring disconnect Defective Power Entry Module Power supply is not recognizing A/C	Check all connections-especially by compressor Replace Power Entry Module Replace Power supply
Excessive battery heat (internal only)	Battery PCB improperly wired Bad battery PCB Bad thermal fuse Bad battery	Check wiring Replace Battery PCB Check/replace battery Check/replace battery
Flickering LED	Excessively discharged battery state Loose connections Bad power driver PCB Transition Board fault	Allow to charge-should self-resolve Check connections Replace power driver PCB (GDE) Replace Transition board
Alarms when Unit is "off"	Excessively discharged battery State Bad LED indicator panel	Allow to charge Replace LED indicator panel
LED red to green - no yellow (external battery only)	Can occur normally with ext battery charge	Perform discharge/recharge cycle

2. Compressor

! All symptoms below assume NO wall air in use

* Compressor/Board must be replaced together on older units

* Check all cables and connector before replacing parts.

No compressor function (and no indicator)	Standard unit - without compressor Bad Air Calibration Bad Blended Gas Calibration Blown fuse on compressor PCB Bad compressor PCB	Option on AVEA 200 Check Air Calibration Check Blended gas Calibration Replace compressor PCB Replace compressor PCB
No compressor function (indicator present)	Unit is reading air pressure with none present.	Blown Air Pressure Transducer. See Pneumatic troubleshooting
"Loss of gas" alarms without O2 in use	Low compressor output Compressor leak Accumulator depletion	Check output - replace compressor if necessary Check tubing/connections Check for excessive patient minute ventilation
"Loss of air" alarms with O2 in use	Low compressor output Compressor leak Accumulator depletion	Check output - replace compressor if necessary Check tubing/connections Check for excessive patient minute ventilation
Excessive compressor noise/vibration	Incorrect mounting Defective/worn Vibration dampeners	Insure mounting nuts are present and tightened Replace Vibration dampeners

Symptom	Problem	Solution(s)

3. EPM

! All symptoms below apply to WFS, Esoph and Aux - unless otherwise noted.

* Available in AVEA Comprehensive only

* Paux and Pesoph not available in software ver 2.7

Erroneous readings from sensor	Bad Sensor Transducer(s) out of calibration Leak	Change/Replace sensor Recalibrate Check all internal/external connections
No reading from sensor	Bad sensor (cable/connector) Specified transducer out of cal No communication from EPM	Try different sensor Check error log for specific transducer. Recalibrate Check internal connections. Replace EPM if needed
"Device Error" when sensor connected	Bad sensor (cable/connector) Specified transducer out of cal No communication from EPM	Try different sensor Check error log for specific transducer Recalibrate Check internal connections. Replace EPM if needed

4. Exhalation Valve/Assembly

Low measured exhaled volumes	Internal leak External leak	Re-seat GDE Check all circuit connections Check filter assembly Check/Replace exhalation diaphragm
Will not pass EST "leak test"	Internal leak External leak	Re-seat GDE Check all circuit connections Check filter assembly Check/Replace exhalation diaphragm
Valve noise	Diaphragm is out of position	Clean/re-seat diaphragm
Excessive expiratory resistance	Moisture in Exhalation Filter Clogged/Dirty Exhalation diaphragm	Bypass filter and recheck. Replace if necessary Clean/replace diaphragm
Abnormal expiratory waveforms	Bad expiratory valve	Replace valve

5. Flow Sensors (inc. Wye)

* See TCA/PCB troubleshooting for additional information		
Volumes become inaccurate over time	Foreign material on flow sensor Expiratory or Wye flow out of calibration-depending on sensor used	Clean/replace sensor as needed Re-calibrate and recheck volumes

Symptom	Problem	Solution(s)
No reading from external variable orifice sensor	Sensor not active in certain modes Loose External connection/Bad Sensor Loose internal connection Communications error	See operators manual for correct sensor/mode configurations Check external connection/replace sensor Check all cables/connections See "EPM" troubleshooting section
No reading from internal variable orifice sensor	Loose External connection/Bad Sensor Loose internal connection Communications error	Check external connection/replace sensor Check all cables/connections Replace TCA/PCB (GDE)
No reading from external heated wire sensor	Sensor not active in certain modes Loose External connection/Bad Sensor Loose internal connection Communications error	See operators manual for correct sensor/mode configurations Check external connection/replace sensor Check all cables/connections Replace TCA/PCB (GDE)
Volume reading above baseline on test lung	Normal condition. Unit expects gas at BTPS, not ATPD	N/A
Volume reading above/below baseline on patient (internal sensor)	Humidifier "Active on/off" set incorrectly Bad Flow sensor Expiratory flow out of calibration Bad pressure transducer	"Active on" for humidifier, "Active off" for HME Check for correct zero with Wye sensor. If Wye sensor zeros correctly, recalibrate Expiratory flow and recheck. Replace internal sensor if needed. If Internal/external sensors both zero incorrect after recal, bad pressure transducer-replace (GDE)

6. Nebulization System

Nebulizer output absent	Unit running on compressor or flow < 15 L/min Bad Nebulizer Solenoid Transition PCB- bad harness connection Problem on Power PCB	Connect wall air, increase flow (if applicable) Replace Solenoid Replace Transition PCB (if solenoid doesn't fix)* Replace Power PCB (if solenoid doesn't fix)*
Nebulizer output reduced/absent	Neb booster output low Kinked tubing externally Kinked tubing internally Bad Neb Booster Solenoid	Adjust Neb booster output Check/replace tubing to nebulizer Check unit for kinks or disconnects Replace Solenoid

* Check Voltage at Solenoid (both). Should be 12v/0v while running with cycling heard. If voltage problem is seen - suspect problem at areas.

with "*"

7. O2 Sensor

"***" on Fi02 monitor	Fi02 reading out of upper or lower range	Recalibrate/replace sensor
O2 reading inaccurate	Fi02 sensor out of calibration Blocked sensor orifice Malfunctioning Blender	Recalibrate/replace sensor Insure patentcy of orifice Replace Blender Assy (GDE)

Symptom	Problem	Solution(s)
	Assembly.	
O2 will not read	Bad 02 sensor Bad 02 sensor cable TCA board problem	Replace sensor Replace sensor cable Replace TCA board (GDE)

8. Pneumatic System

! Check error log (and exceptions) with any "Device Error" or "Inop" condition to diagnose component.

Component	Symptom	Problem	Solution(s)
Air Pressure PCB	Vent Inop. (communications failure)	Bad connections/cable EPROM failure Incorrect calibration	Check connections/replace cable Replace Air PCB-recalibrate Recalibrate
	Incorrect pressure reading	Bad Transducer Incorrect calibration	Replace Air PCB-recalibrate Recalibrate
02 Pressure PCB	Vent Inop. (communications failure)	Bad connections/cable EPROM failure Incorrect calibration	Check connections/replace cable Replace 02 PCB-recalibrate Recalibrate
	Incorrect pressure reading	Bad Transducer Incorrect calibration	Replace 02 PCB Recalibrate
Blended Gas PCB	Vent Inop. (communications failure)	Bad connections/cable EPROM failure Incorrect calibration	Check connections/replace cable Replace Blended Gas PCB-recalibrate Recalibrate
	Incorrect pressure reading	Bad Transducer Incorrect calibration	Replace Blended Gas PCB-recalibrate Recalibrate
Blender	Vent Inop.	Bad connections/cable EPROM failure Incorrect calibration	Check connections/replace cable Replace Blender (GDE) Recalibrate
	Fi02 Inaccuracy	Blender Assembly Failure Regulator Relay out of balance Leak	Replace Blender (GDE) Recalibrate Regulator Relay Check all pneumatic connections
Flow Control Valve	Inspiratory Noise	FCV out of characterization Defective FCV	Re-characterize FCV * Replace FCV (GDE)

Component	Symptom	Problem	Solution(s)
	Flow Abnormalities	FCV out of characterization Defective FCV	Re-characterize FCV * Replace FCV (GDE)
Inspiratory Flow Sensor	Autocycling	Leak at FCV/IFS Bad IFS	Check all connections Replace IFS (GDE)
	Incorrect delivery	Leak at FCV/IFS Bad IFS	Check all connections Replace IFS (GDE)
	Vent Inop	Bad Connection/cable Bad IFS	Check all connections/replace cable Replace IFS (GDE)
Safety Relief Valve	Breath delivered-no output to patient	Leak in safety solenoid tubing/connections Bad safety solenoid Problem in TCA board	Check all connections " Replace safety solenoid Replace TCA (GDE)
	Mechanical overpressure release prematurely	Incorrect Setting	Reset overpressure setting * (replace)

All items marked with an "*" are done at factory.

9. UIM/Control System

Symptom	Problem	Solution(s)
Unit continues to run after being switched off	Disconnected wire on "on/off" switch Bad "on/off" switch	Check wiring in GDE Replace switch
No power to unit and UIM	Fuse/power supply problem	See "Battery/Power supply section"
Unit powers on-UIM doesn't	Damaged/disconnected cable-Ext./Int. Bad Backlight Inverter Blown fuse on TCA Bad TCA Power supply voltage drops w/load	Check/replace all external and internal cables/connections Replace Backlight Inverter Replace fuse Replace TCA (GDE) Replace Power Supply
Membrane buttons not working	"Screen lock" button active Loose connections/bad cable Defective membrane switch assembly	Unlock screen Check all cables/connections Replace switch assembly (UIM)

Symptom	Problem	Solution(s)
Touch screen not working	Loose internal connection Defective touch pad	Check all internal cables/connections Replace touch pad (UIM)
No priority LED's	Bad LED PCB	Replace LED PCB
Optical Encoder (knob) inoperable	Bad Optical Encoder	Replace Optical Encoder
No sound with alarms	Speaker wire loose/disconnected Bad speaker Bad TCA	Check wiring to speaker Replace speaker Replace TCA board (GDE)

Chapter 10 Parts Lists

Note

The list of components given in this manual are for reference only. For a comprehensive part list contact VIASYS Healthcare Critical Care technical support at the number given in Appendix A. Common hardware is not shown in these list.

Table 10.1 User Interface Module list of major components.

Part Number	Description
51000-40244	BEZEL FRONT
62470	LCD MODULE 12.1 IN LQ121 SDG11
66088	LCD, ACTIVE, 12.1 IN, LB121S1-A2
51000-40193	OVERLAY
51-40499-01	MTG PLATE UIM,DETAIL ASSY(LQ121S1DG11 SHARP)
51-40499-02	MTG PLATE UIM,DETAIL ASSY(LB121S1 LG LCD,INC.)
51000-40300	PCB ASSY CONTROL
51000-40594	COVER, ELECT CONNECTOR DETAIL ASSY
51000-40498	SUPPORT BOX,UIM,DETAIL ASSY
51000-40500	SHEILD,SUPPORT BOX-UIM
51000-40072	ARM ASSY,MOUNTING,UIM
51000-40595	BEZEL, BACK - UIM
51000-40593	STRAIN RELIEF, ELECT. BOX, TOP
51000-40592	STRAIN RELIEF ELEC BOX BOT DET ASSY
51000-40633	BOOT RUBBER-UIM ARM
51000-40622	COVER ARM - UIM
51000-40623	COVER INSIDE ARM UIM
51000-40650	PCB ASSY, LED
71681	CABLE, LCD
51000-40681	CABLE ASSY, CONTROL PCB TO LED PCB
51000-40687	CABLE ASSY, CTL PCB TO BACKLT PCB
51000-40764	MOUNTING BLOCK, HEAT PIPE-UIM
51000-40765	MOUNTING BLOCK,TOP, HEAT PIPE-UIM
51000-40766	HEAT PIPE - UIM
51000-40767	RETAINER, HEAT PIPE-CONTROL PCB
51000-40768	RETAINER TOP,HEAT PIPE-CONTROL PCB
66089	TOUCH SCREEN 12"
68276	INVERTER, DC TO AC, 2 TUBE
68267	INVERTER,DC TO AC,L2357
33958	TAPE DBL SIDED .25W X .2T W/468 ADHESIVE & RELEASE LINER
90939	MAG, AVEA,USER INTERFACE MODULE ASSY
33950	GASKET, CHANNEL, EMI
51000-40852	SHIELD,LCD SCREEN,UIM
51000-40839	WIRING DIAGRAM SYSTEM AVEA
52000-01141	GROMMET, CATERPILLAR
S1034	TAPE,GLASS CLOTH-ELEC
51000-08819	LABEL, ATTENTION
51000-40844	SHIELD, LCD - UIM
1009127	TAPE, FOAM, ADHESIVE BACK (3/16THK 3/8W)

9101022	THREADLOCKER, LOCTITE 222
1000-40771	HEAT SINK PAD CPU UIM

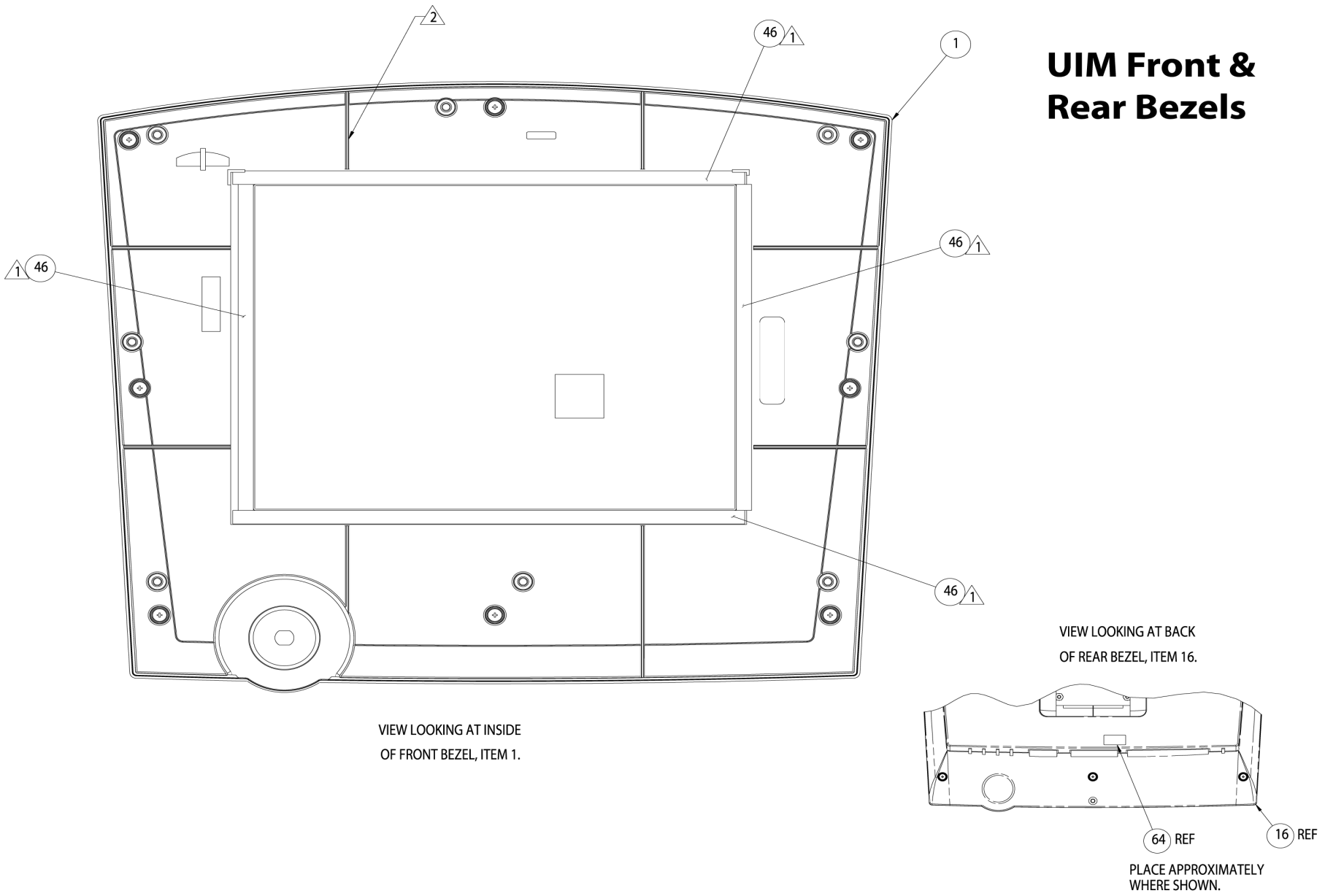


Figure 10.1: UIM Front and Rear Bezels

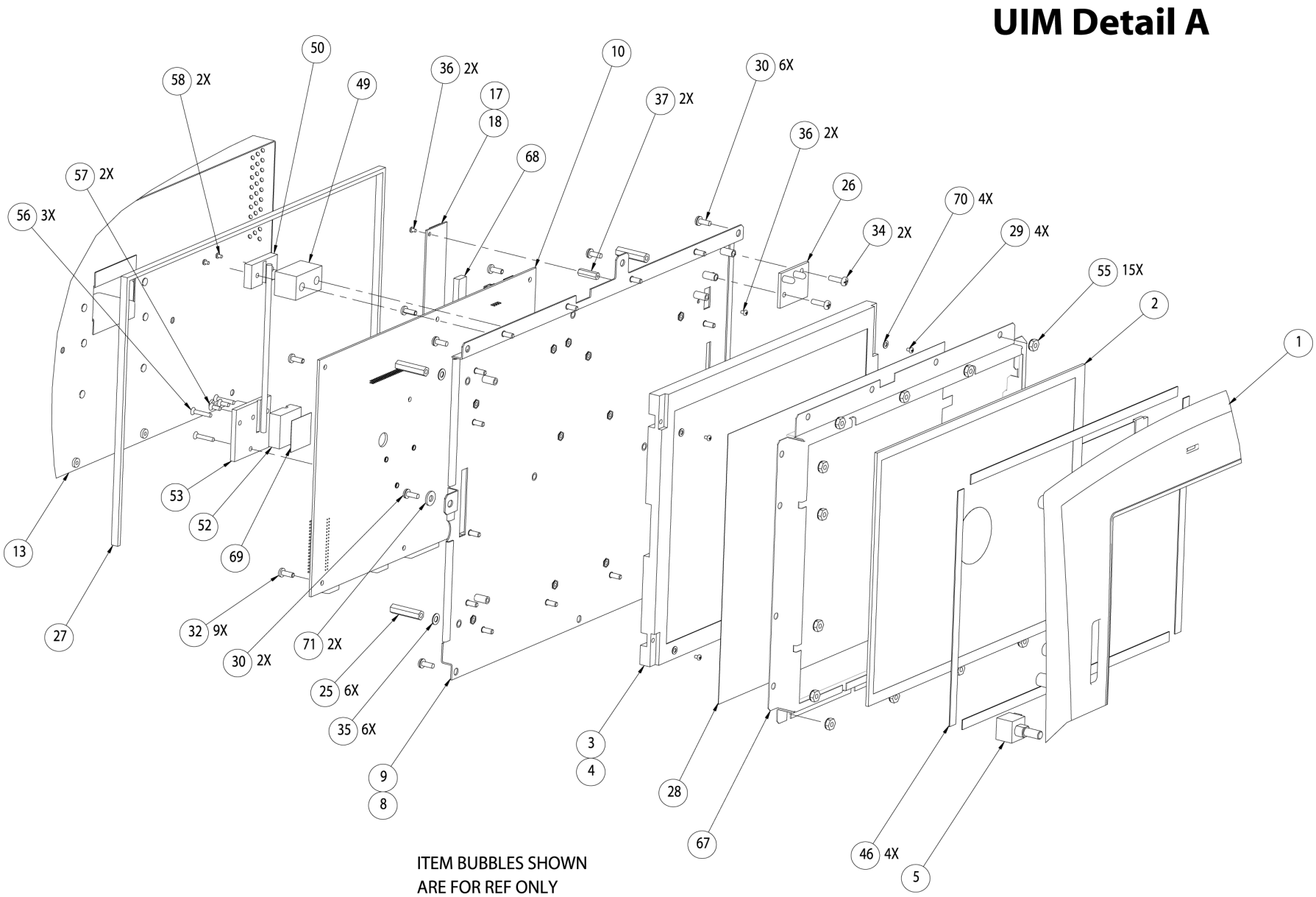


Figure 10.2: UIM Detail A

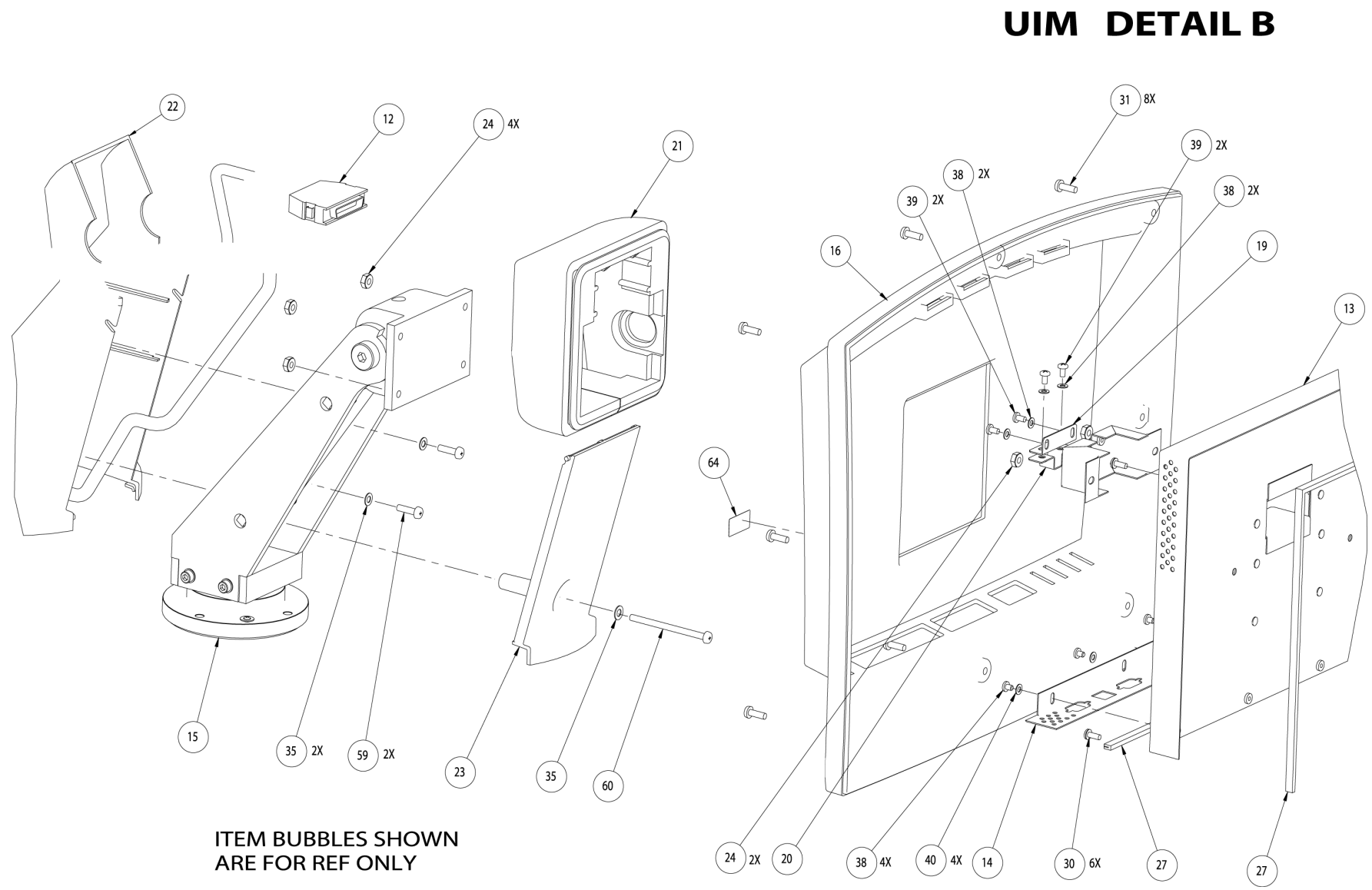


Figure 10.3: UIM Detail B

Table 10.2 Gas Delivery Engine Parts List.

Part Number	Description
51000-40099	INLET ASSEMBLY, GAS DELIVERY ENGINE
50570	PCBA,PATIENT ASSIST CALL
51000-40849	TRAN COM ALARM ASSY
51000-40469	BRACKET,TCA PCB,REAR
71665	FUSE, HOLDER, 5X20MM PNL MNT
51000-40831	HARNESS ASSY, EXT BATT TO PWR DRVR
68274	SWITCH,ROCKER,SPDT,10 AMP
51000-40037	O2 BLENDER ASSY
51000-40043	FLOW SENSOR ASSY
51000-40044	PATIENT OUTLET ASSY
51000-40729	BRACKET,TCA PCB FRONT, DETAIL ASSY
51000-40504	VALVE ASSY,FLOW CONTROL
51000-40320	PCBA,POWER DRIVER BOARD
51000-40835	PCB ASSY, HOUR METER, W/HARNESS
51000-40632	CABLE ASSY,O2 SENSOR
51000-40833	HARNESS ASSY, GAS ID, INTERNAL
52000-00526	FTG BULKHEAD MTG FEMALE LUER X 1/16 TUBN
71660	FUSE,1.25A,SLO-BLO,5X20MM
52000-01205	FITTING, MALE LUER LOCK 1/16 ID TUBING
44029	NUT,LUER,GREEN
44031	NUT, LUER, YELLOW
44030	NUT, LUER, ORANGE
68289	SENSOR,OXYGEN W/CONNECTOR
32008	FITTING,12MM OD TUBE,UNION ELBOW,KQ2L
32009	FITTING,1/8" OD TUBE,UNION TEE,KQ2T
32006	FITTING,1/4" OD TUBE,UNION ELBOW,KQ2L
53021-01018	O-RING 3/4 ID X 1/16 THK SIL RBR 7
53021-01011	O-RING, 5/16 ID X 1/16 THK SIL RBR 70 SH
33960	BUSHING, STRAIN REL, ROUND CABLE
51000-40759	CABLE ASSY, O2 SENSOR, MULTI-CELL
51000-40411	FITTING,AIR INLET
40523	SCREW,6-32 X .375, BH CAP CRES
33965	STANDOFF,6-32 X 1.38,M/F,HEX
51000-40772	CABLE ASSY, TCA TO NURSE CALL
51000-40786	CABLE ASSEMBLY, PDB TO TCA
71656	CABLE,FLAT/FLX,30-COND,1.25MM
71657	CABLE,FLAT/FLX,12-COND,3",1.00
71658	CABLE,FLAT/FLX,26-COND,4",1.00
32057	ORIFICE,METAL,1/16" TUBING
51000-40816	HEAT SINK PAD POWER DRIVER PCB
23031	FITTING, BULKHEAD UNION 1/8OD TUBE
32063	PLUG,1/8 OD TUBE FITTING
33982	TUBING,1/8 OD,POLYURETHANE,GREEN
33994	TUBING,1/8 OD,POLYURETHANE,BLUE
51000-40841	TUBING DIAGRAM,AVEA
51000-40831	HARNESS ASSY, EXT BATT TO PWR DRVR

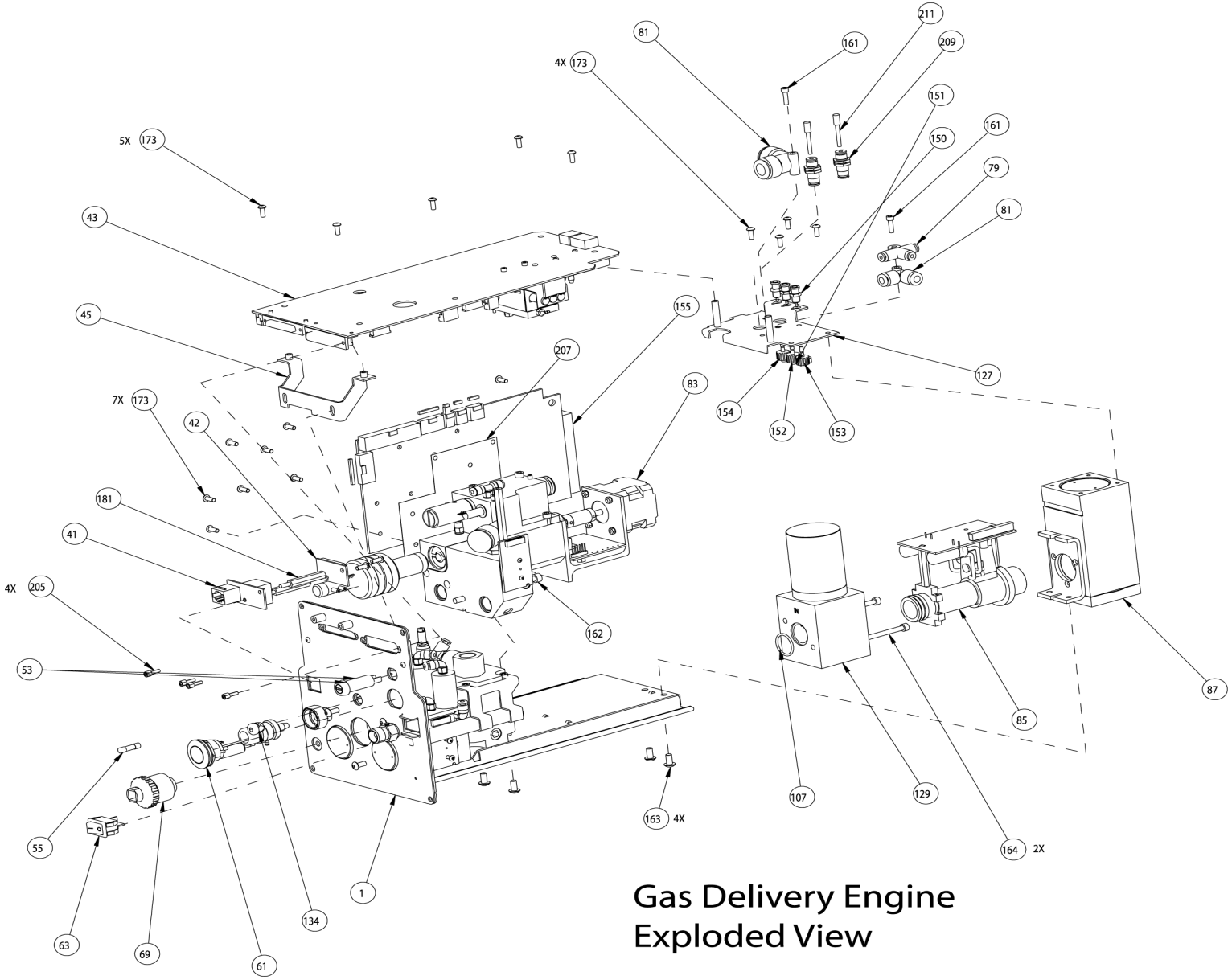
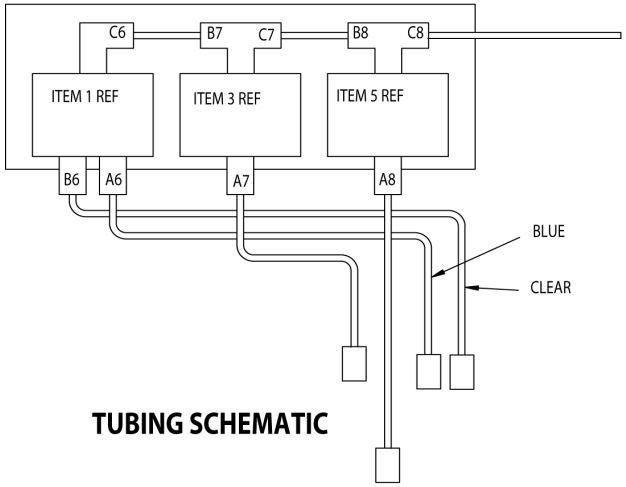
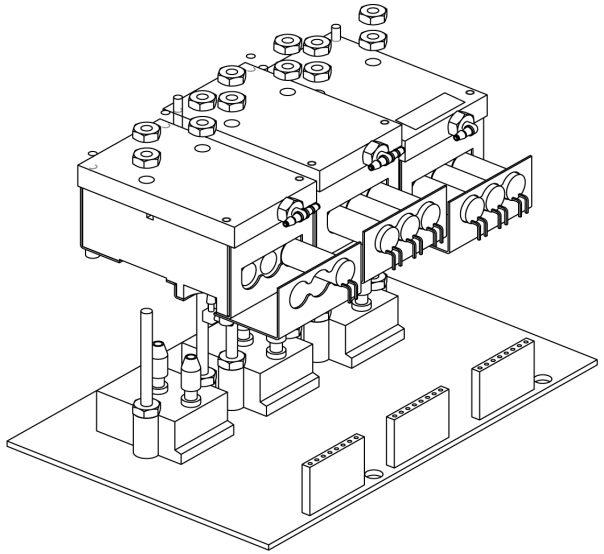
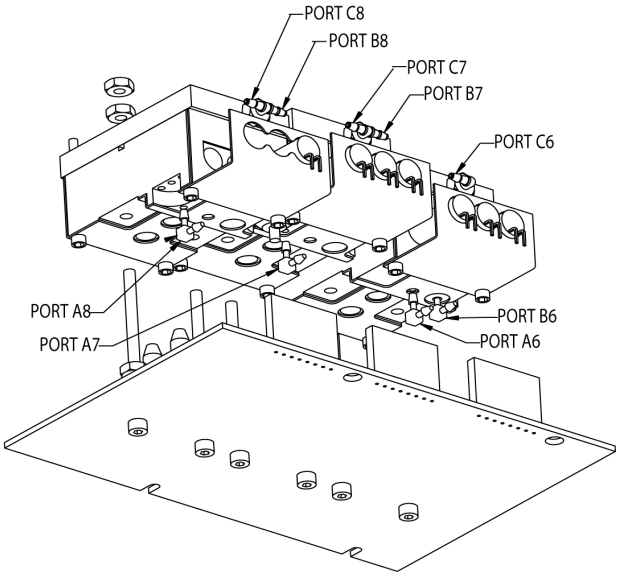


Figure 4.18: Gas Delivery Engine



TUBING SCHEMATIC





EPM ASSEMBLY

51000-40848 REV A

Figure 4.27: EPM Assembly

Top Assembly Parts List

Table 10.3 Top Level Parts List

Part Number	Description
51000-40008	PNEUMATIC MOD,ASY,AVEA,GENERIC
51000-40084	PANEL ASSY, INTERFACE/STATUS, COMPR
51000-09750	COMPRESSOR ASSEMBLY,SCROLL
51000-40848	EPM ASSY
52000-00308	NUT, KEPS 8-32
40513	SCREW,PAN HEAD CR, 8-32X0.375,STEEL W/ZINC
90962	MAG,AVEA,CPRSR. PNEU.MOD
51000-40614	BRACKET,CABLE RETAINER,PNEU MODULE
51000-40839	WIRING DIAGRAM SYSTEM AVEA
51000-40841	TUBING DIAGRAM,AVEA
51000-40635	FRONT PANEL - PNEUMATIC MODULE
51000-40226	COVER,TOP
51000-40634	TOP COVER ASSY, PNEUMATIC MODULE
90976	DRS, AVEA, PNEU MDL CPRSR
S1034	TAPE,GLASS CLOTH-ELEC
51000-40506	CHASSIS,DETAIL ASSY-PNEU MODULE ENGINE
51000-40748	ACCUMULATOR ASSY, RIGID
51000-40547	FITTING, PATIENT
51000-40619	PLATE, PATIENT OUTLET MOUNTING
51000-40635	FRONT PANEL - PNEUMATIC MODULE
51000-40211	RAIL,HANDLE,PNEUMATIC MODULE
51000-40210	RAIL HANDLE SUPPORT-PNEU MODULE
51000-40214	HANDLE,REAR,PNEUMATIC MODULE
51000-40215	COVER, HANDLE- PNEUMATIC MODULE
51000-40615	BRACKET,SPEAKER PNEUMATIC MODULE
51000-40612	SHIELD-COVER,EXHALATION CONN
51000-40611	SHIELD,EXHALATION CONNECTOR
51000-40231	COVER,BOTTOM
51000-40229	PANEL,REAR,DETAIL ASSY
51000-40076	EXHALATION ASSEMBLY
68273	POWER SUPPLY, 31V, 8AMP
51000-40523	BRACKET,POWER SUPPLY
68291	BATTERY ASSY, 12V, 4.5AH, NIMH
51000-40223	BRACKET,BATTERY
51000-40573	BRACKET ASSY,DRIVER TRANSITION PCB
51000-40618	BRACKET,TRANSTION DRIVER MOUNT- PNEU MODULE
51000-40660	MANIFOLD,PATIENT OUTLET
33915	FILTER,GUARD ASSY,COOLING FAN
51000-40022	GAS DELIVERY ENGINE ASSY
51000-40802	HOUSING,CORNER,DETAIL ASSY
52000-00311	NUT KEPS 1/4-20 X 15/64 TH
52000-00308	NUT, KEPS 8-32
51000-40763	HOLDER, PATIENT FITTING
51000-40770	BRACKET,LOCKING,GDE

51000-40749	FAN,INTAKE ASSEMBLY
51000-40861	FAN ASSY, W/WELDNUTS
33941	VENT,FAN,SHIELDED
51000-40728	BRACKET,AC
51000-40678	LATCH EXHALATION
51000-40730	LATCH,STOP,DETAIL ASSY
51000-40804	BOLT, SHOULDER, EXHALATION ASSY
51000-40762	HOLDER,WATER TRAY
51000-40726	TRAY,EXHALATION
51000-40745	JACKET, HANDLE, LEFT
51000-40746	JACKET, HANDLE, RIGHT
51000-40779	CABLE ASSY, TCA TO VARFLEX
51000-40782	CABLE ASSY, EPM TO PDT
51000-40818	SPEAKER ASSY
15891	FAN, ASSEMBLY, 12VDC, 550MA
51000-40827	POWER ENTRY MODULE ASSY, AVEA
51000-40829	DRIVER TRANSITION PCB, W/HARNESS
51000-40839	WIRING DIAGRAM SYSTEM AVEA
51000-40841	TUBING DIAGRAM,AVEA
51000-40026	NEBULIZER ASSEMBLY
68259	SPEAKER, 250-8.0KHZ, 6W 8 OHM
51000-40827	POWER ENTRY MODULE ASSY, AVEA
51000-40862	SHIELD, POWER SUPPLY
51000-40550	PCBA,DRIVER TRANSITION
9456	PLUG,GROUND REAR PNL
53013-69602	WASHER NYL
68159	FUSEHOLDER, 5X20 .250 TA
71660	FUSE,1.25A,SLO-BLO,5X20MM
3519	TERM,FEM,.250 18-22 DBL CRIMP
68294	SWITCH,SNAP ACTION,ROLLED LEVER
S1034	TAPE,GLASS CLOTH-ELEC

Appendix A Contact & Ordering Information

How to Call for Service

To get help on performing any of the preventive maintenance routines, or to request service on your ventilator, contact VIASYS Healthcare Customer Care:

Technical Service

Hours: 7:00 AM to 3:30 PM (PST) Monday through Friday
Phone: (760) 778-7200
Fax: (760) 778-7377

VIASYS Healthcare Customer Care Helpline

Hours: 24 hours, seven days a week

Phone: (800) 934-2473 (From within the US)
Fax: (760) 778-7377

VIASYS Healthcare Critical Care
1100 Bird Center Drive
Palm Springs, CA 92262-8099
U.S.A.

Phone: (760) 778-7200
(800) 328-4139

Fax: (760) 778-7274

Ordering Parts

To obtain AVEA Ventilator parts contact customer service at:

VIASYS Healthcare Customer Service:

Hours: 7:00 Am to 3:30 PM (PST)
Monday through Friday

Phone: (800) 328-4139
(760) 778-7200

Fax: (760) 778-7274

Appendix B Diagrams and Schematics

The drawings and schematics presented in this manual are for reference purposes only. It is possible that later versions of these documents may become available after this manual print date. VIASYS Healthcare will provide upon request and to qualified persons any and all diagrams, technical drawings and other information necessary to repair, maintain or service the AVEA Ventilator systems. Contact VIASYS Healthcare Technical Support or your local VIASYS Healthcare representative for information.

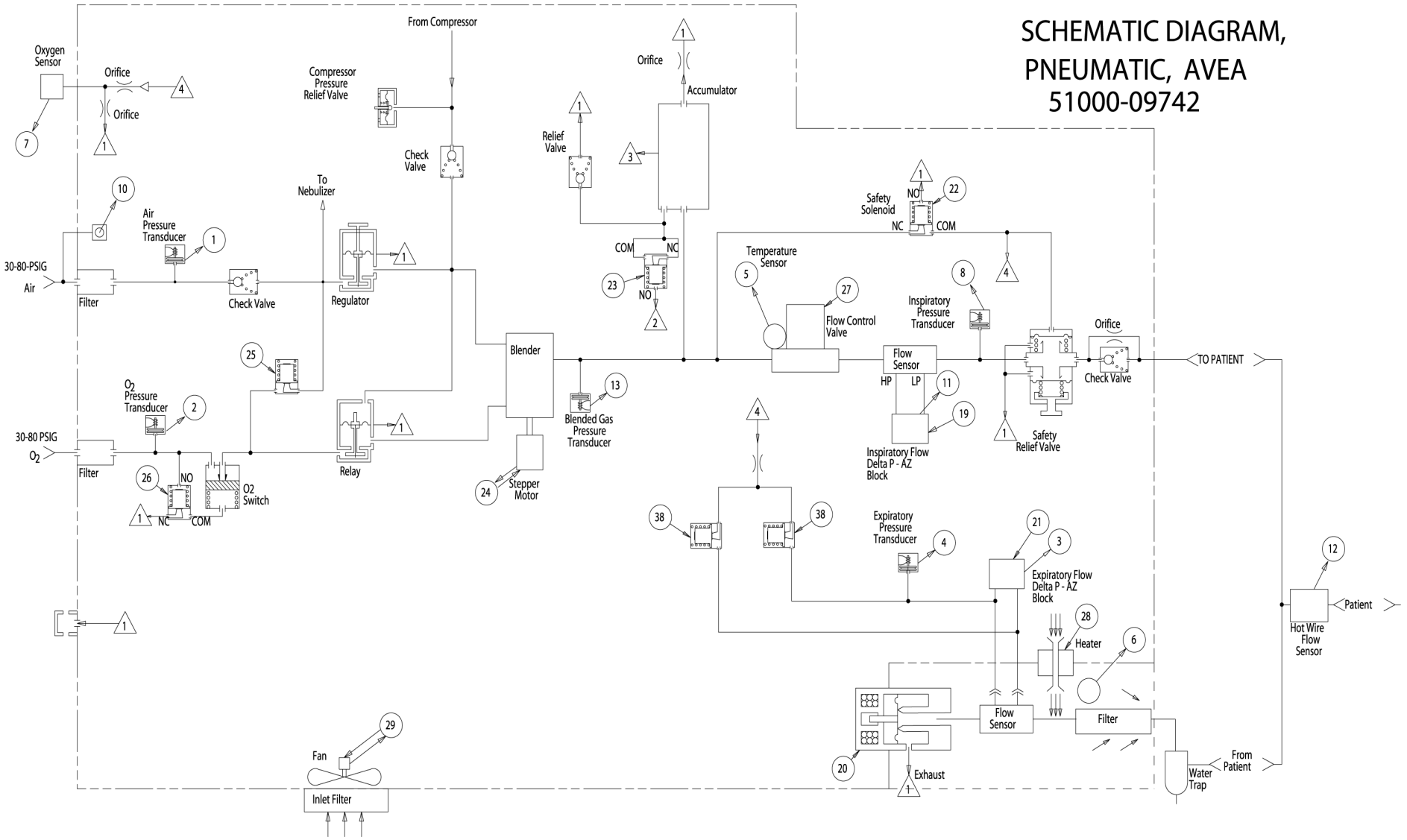
Pneumatic Schematic, Part Number 51000-09742

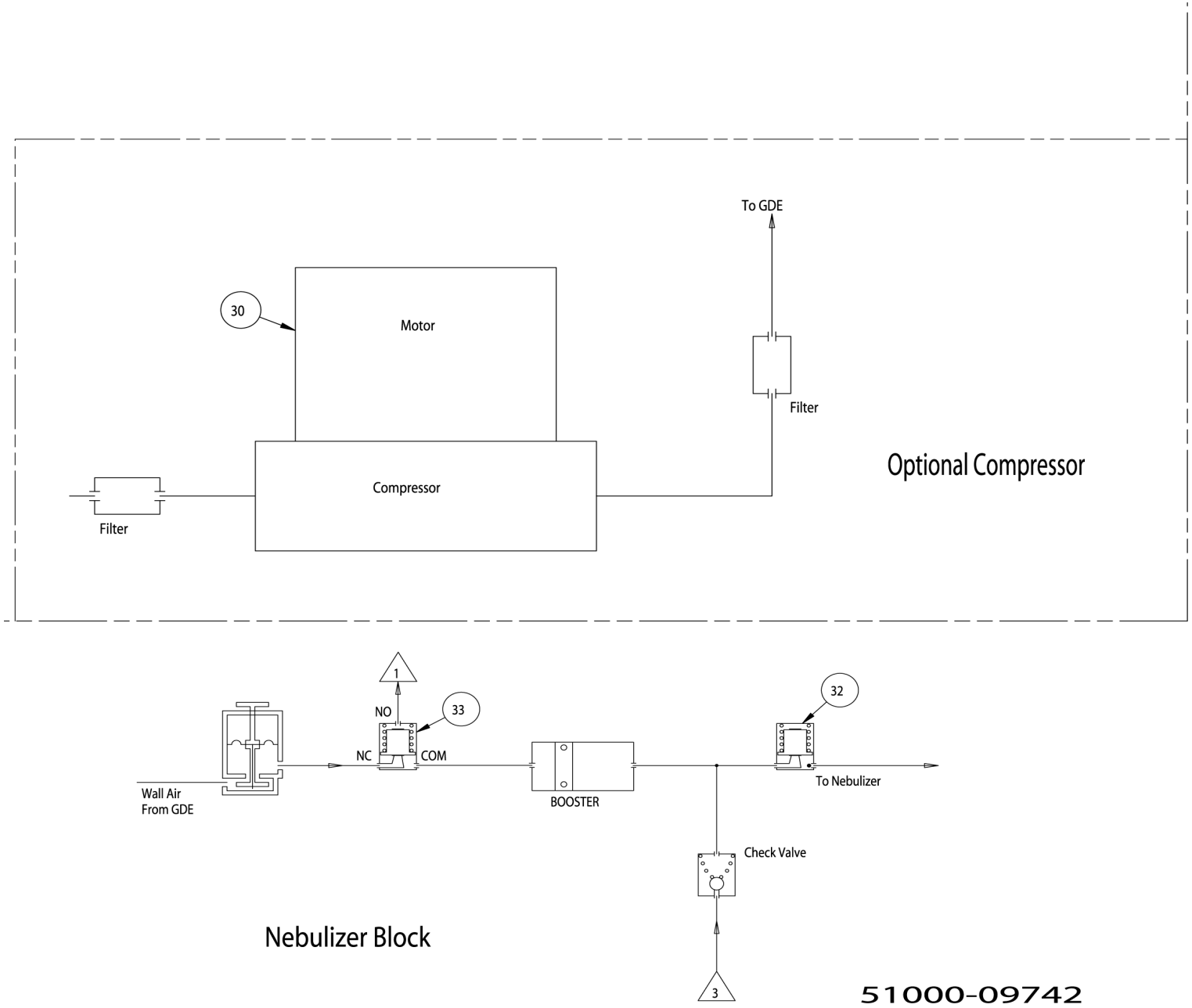
Pneumatic Schematic Page 1
Pneumatic Schematic Page 2
Pneumatic Schematic Page 3
Pneumatic SchematiccPage 4

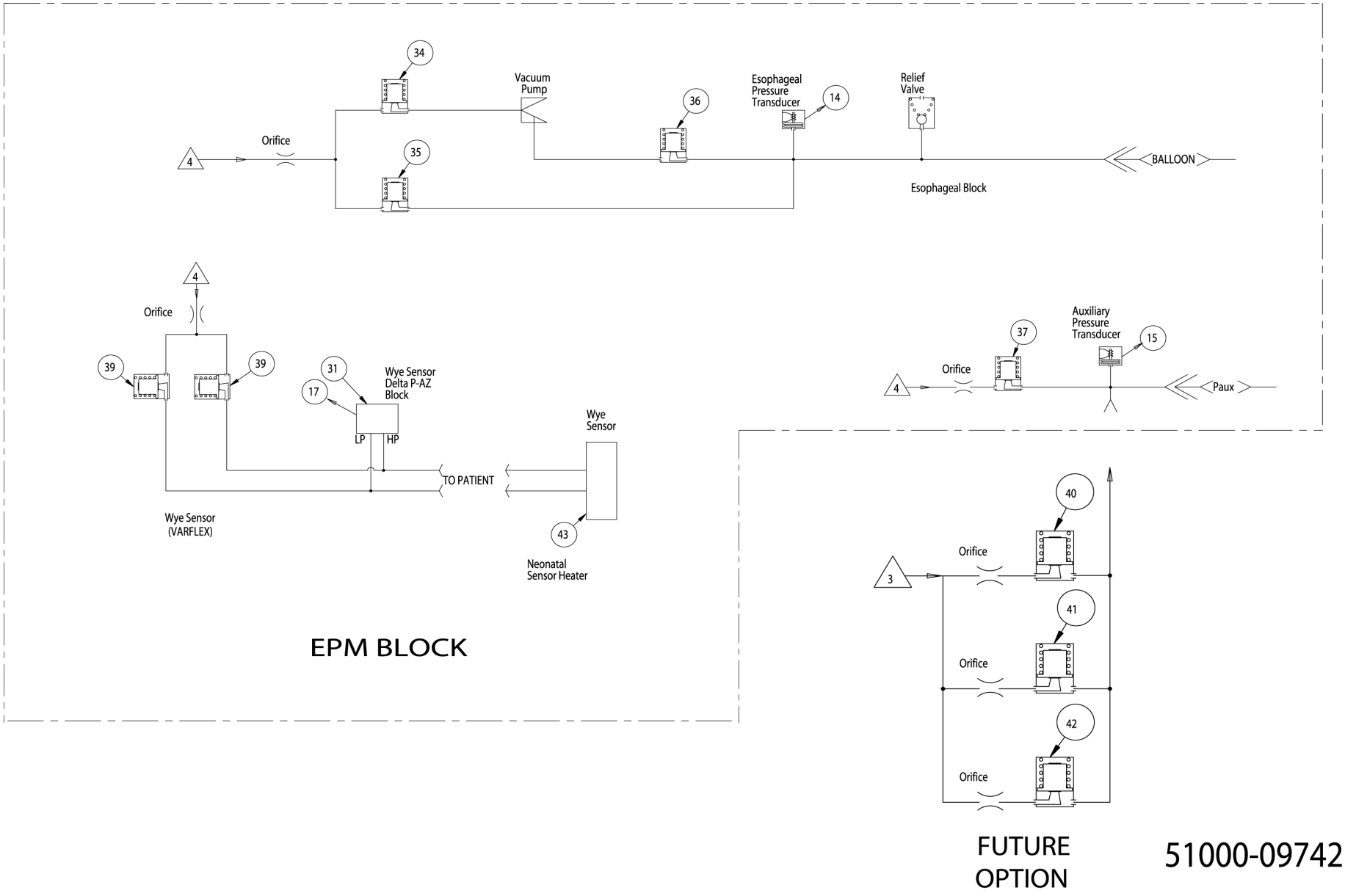
Tubing Diagram, Part Number 51000-40841

Wiring Diagram, Part Number 51000-40839

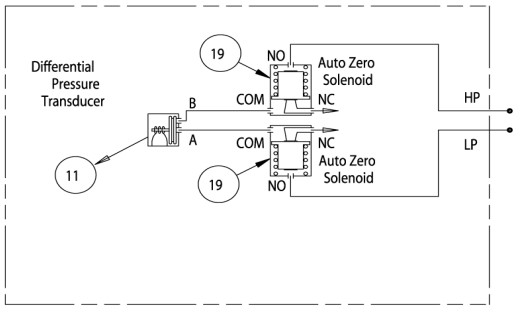
Wiring Dagram Page 1
Wiring Diagram Page 2


SCHEMATIC DIAGRAM,
PNEUMATIC, AVEA
51000-09742
From Compressor
Oxygen Sensor
Orifice
Orifice
Compressor Pressure Relief Valve
Check Valve
To Nebulizer
Relief Valve
Orifice
Accumulator
Air Pressure Transducer
30-80-PSIG Air
Filter
Check Valve
Regulator
COM
NC
NO
Safety Solenoid
NC
NO
COM
Temperature Sensor
Flow Control Valve
Inspiratory Pressure Transducer
Orifice
TO PATIENT
Blender
Flow Sensor
HP
LP
Check Valve
Safety Relief Valve
Inspiratory Flow Delta P - AZ Block
O2 Pressure Transducer
30-80 PSIG O2
Filter
Relay
Blended Gas Pressure Transducer
Stepper Motor
O2 Switch
NO
NC
COM
Expiratory Pressure Transducer
Expiratory Flow Delta P - AZ Block
Heater
Hot Wire Flow Sensor
Patient
Fan
Inlet Filter
Flow Sensor
Filter
Exhaust
Water Trap
From Patient

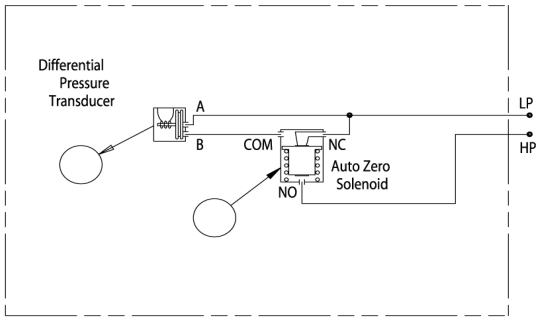

To GDE
30
Motor
Filter
Compressor
Filter
Optional Compressor
1
NO
33
NC
COM
32
Wall Air
From GDE
BOOSTER
To Nebulizer
Check Valve
Nebulizer Block
3
51000-09742


34
Vacuum Pump
36
Esophageal Pressure Transducer
14
Relief Valve
Orifice
4
35
BALLOON
Esophageal Block
4
Orifice
39
39
31
17
Wye Sensor Delta P-AZ Block
LP
HP
Wye Sensor
TO PATIENT
Wye Sensor (VARFLEX)
43
Neonatal Sensor Heater
EPM BLOCK
37
Auxiliary Pressure Transducer
15
Orifice
4
Paux
40
Orifice
3
41
Orifice
42
Orifice
FUTURE OPTION
51000-09742

INSPIRATORY FLOW
DELTA P - AZ BLOCK



TYPICAL DELTA P-AZ BLOCK



51000-09742-4

COMMUNICATION BETWEEN BLOCKS

1. OVERBOARD EXHAUST.
2. ACCUMULATOR FLUSH/WATER DUMP EXHAUST
3. BLENDED GAS FROM GDE.
4. BLENDED GAS FROM SAFETY SV

TRANSDUCER SIGNALS

1. AIR XDUCER
2. OXYGEN XDUCER
3. EXP FLOW DIF. XDUCER
4. EXP. XDUCER
5. INSP. TEMP. SENSOR
6. EXH SYSTEM TEMP. SENSOR
7. OXYGEN SENSOR
8. INSP XDUCER
9.
10. GAS TYPE ID
11. INSP FLOW DIF. XDUCER
12. HOT WIRE SENSOR
13. BLENDED GAS XDUCER
14. PES XDUCER
15. AUXILIARY XDUCER
16.
17. FAW DIF. XDUCER
18.

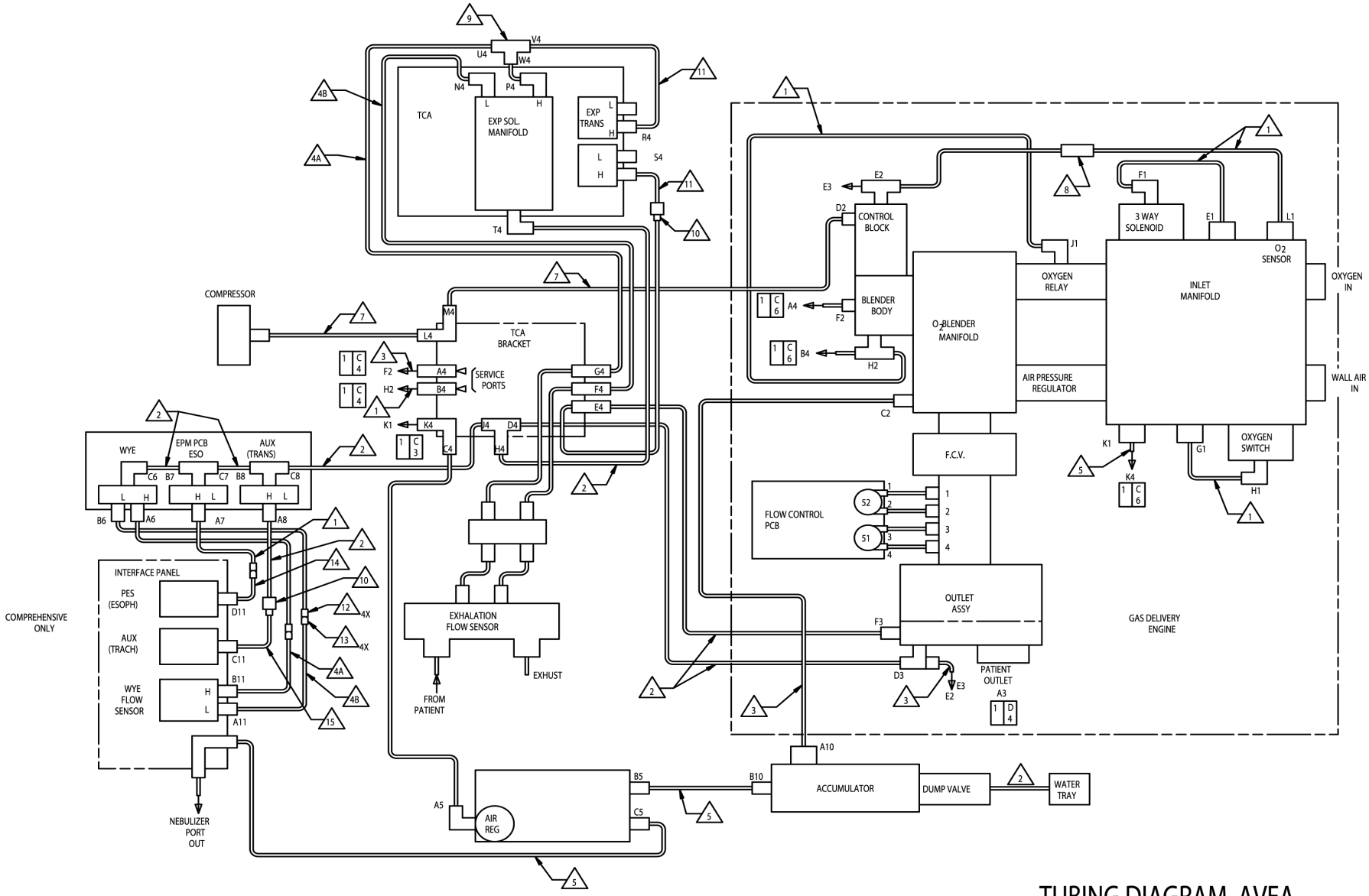
CONTROL SIGNALS

19. INSP AZ SV
20. ACTIVE EXHALATION VALVE
21. EFS AZ SV
22. SAFETY SV
23. WATER DUMP SV
24. BLENDER STEPPER MOTOR
25. CROSSOVER SV
26. OXYGEN SWITCH SV
27. GAS CV
28. HEATER
29. FAN MOTOR
30. COMPRESSOR MOTOR
31. FAW AZ SV
32. NEBULIZER SV
33. BOOSTER DRIVE SV
34. VACUUM PUMP SV
35. ESOP FILL SV
36. ESOP EVACUATION SV
37. PROX PURGE SV
38. EFS PURGE SV
39. WFS PURGE SV
40. 2 LPM SV
41. 4 LPM SV
42. 6 LPM SV
43. NEONATOL SENSOR HEATER

ABBREVIATIONS

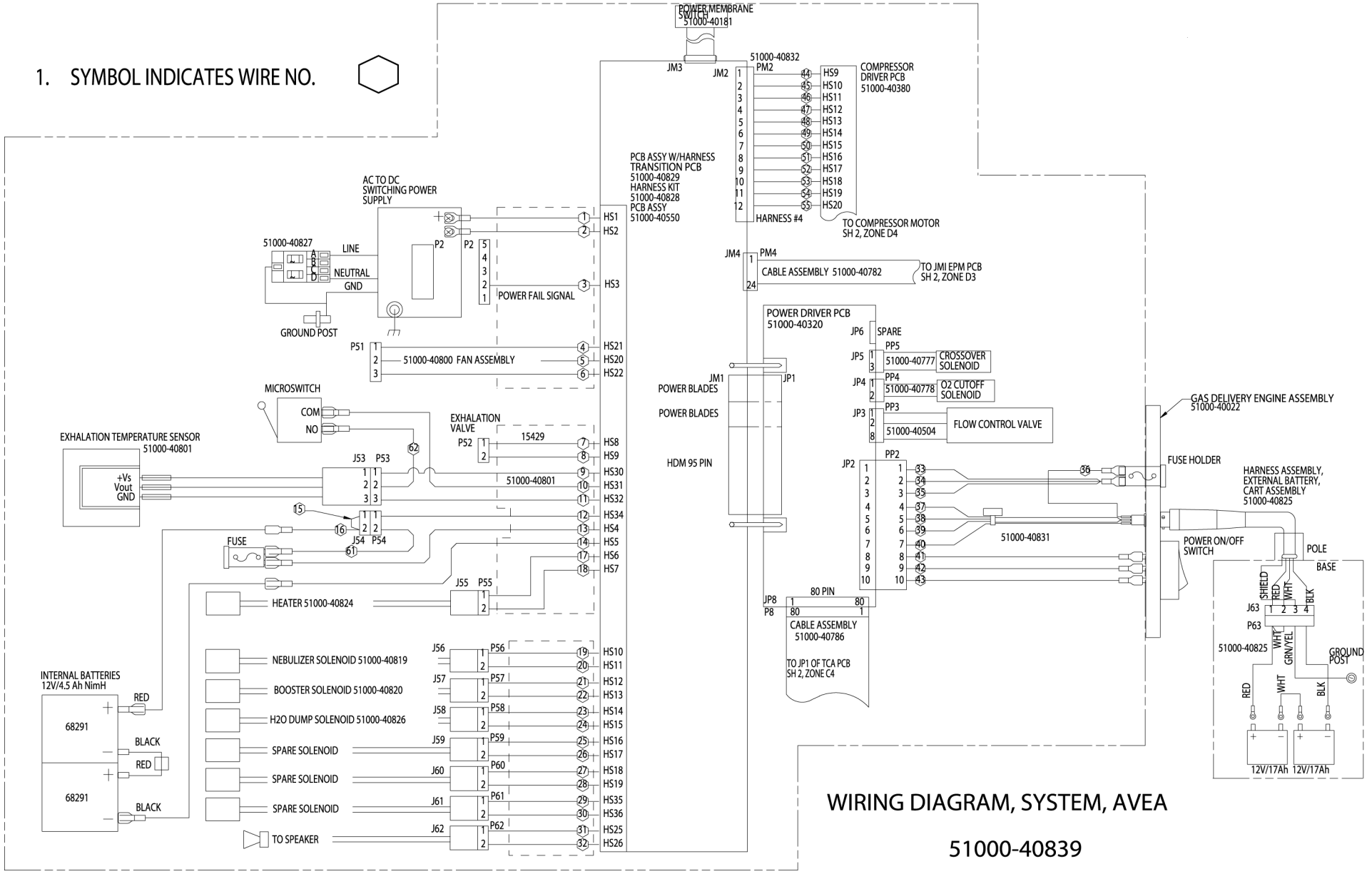
AZ - AUTO ZERO.
CV - CONTROL VALVE.
DIF XDUCER - DIFFERENTIAL PRESSURE TRANSDUCER.
EFS - EXHALED FLOW SENSOR
EPM - ENHANCED PATIENT MONITORS
ESOP - ESOPHAGEAL.
EXH - EXHALATION
EXP - EXPIRATORY.
FAW - AIRWAY FLOW
GDE - GAS DELIVERY ENGINE.
HP - HIGH PRESSURE.
ID - IDENTIFIER.
INSP - INSPIRATORY.
LP - LOW PRESSURE.
PAUX - AUXILIARY PRESSURE
PAW - PROXIMAL (AIRWAY) PRESSURE.
PES - ESOPHAGEAL PRESSURE.
PR - PRESSURE RELIEF
PROX - PROXIMAL
PTR - TRACHEAL PRESSURE.
SR - SAFETY / RELIEF VALVE.
SV - SOLENOID VALVE.
TEMP - TEMPERATURE.
WFS - WYE FLOW SENSOR
XDUCER - TRANSDUCER.

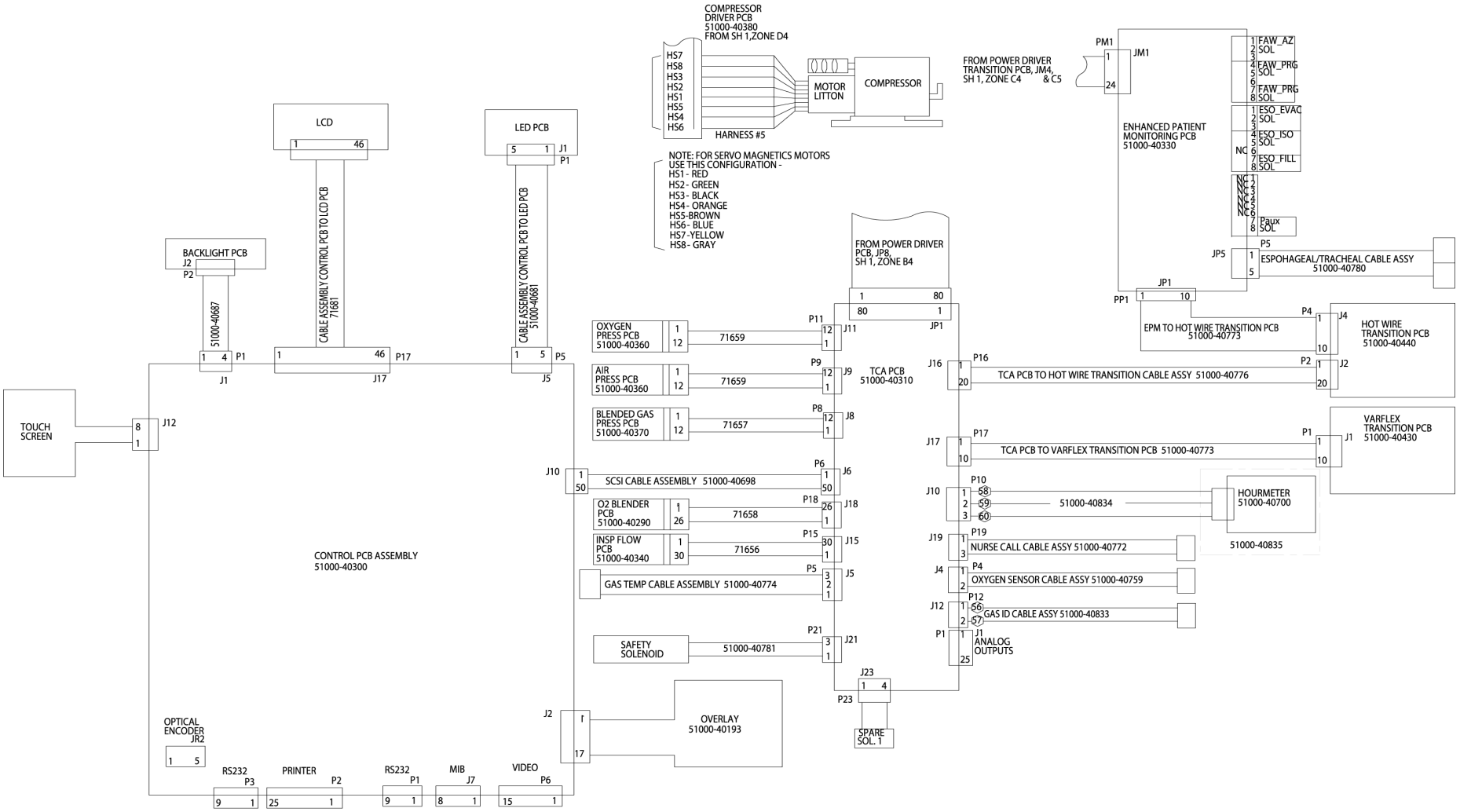
NOTE: SYSTEM IS SHOWN IN DE-ENERGIZED STATE.



TUBING DIAGRAM, AVEA

51000-40841


1. SYMBOL INDICATES WIRE NO.
POWER MEMBRANE SWITCH 51000-40181
JM3
JM2
51000-40832 PM2
COMPRESSOR DRIVER PCB 51000-40380
HS9
HS10
HS11
HS12
HS13
HS14
HS15
HS16
HS17
HS18
HS19
HS20
HARNESS #4
TO COMPRESSOR MOTOR SH 2, ZONE D4
PCB ASSY W/HARNESS TRANSITION PCB 51000-40829 HARNESS KIT 51000-40828 PCB ASSY 51000-40550
JM4
PM4
CABLE ASSEMBLY 51000-40782
TO JMI EPM PCB SH 2, ZONE D3
AC TO DC SWITCHING POWER SUPPLY
51000-40827
LINE
NEUTRAL
GND
GROUND POST
P2
POWER FAIL SIGNAL
HS1
HS2
HS3
P51
51000-40800 FAN ASSEMBLY
HS21
HS20
HS22
POWER DRIVER PCB 51000-40320
JP6
SPARE
PP5
JP5
51000-40777
CROSSOVER SOLENOID
PP4
JP4
51000-40778
O2 CUTOFF SOLENOID
PP3
JP3
51000-40504
FLOW CONTROL VALVE
JM1
JP1
POWER BLADES
POWER BLADES
HDM 95 PIN
PP2
JP2
GAS DELIVERY ENGINE ASSEMBLY 51000-40022
FUSE HOLDER
HARNESS ASSEMBLY, EXTERNAL BATTERY, CART ASSEMBLY 51000-40825
51000-40831
POWER ON/OFF SWITCH
POLE
BASE
SHIELD
RED
WHT
BLK
J63
P63
51000-40825
WHT
GRN/YEL
GROUND POST
RED
WHT
BLK
12V/17Ah
12V/17Ah
MICROSWITCH
COM
NO
EXHALATION TEMPERATURE SENSOR 51000-40801
+Vs
Vout
GND
J53
P53
J54
P54
FUSE
EXHALATION VALVE
15429
P52
51000-40801
HS8
HS9
HS30
HS31
HS32
HS34
HS4
HS5
HS6
HS7
J55
P55
HEATER 51000-40824
80 PIN
JP8
P8
CABLE ASSEMBLY 51000-40786
TO JP1 OF TCA PCB SH 2, ZONE C4
INTERNAL BATTERIES 12V/4.5 Ah NimH
68291
68291
RED
BLACK
RED
BLACK
NEBULIZER SOLENOID 51000-40819
BOOSTER SOLENOID 51000-40820
H2O DUMP SOLENOID 51000-40826
SPARE SOLENOID
SPARE SOLENOID
SPARE SOLENOID
TO SPEAKER
J56
P56
J57
P57
J58
P58
J59
P59
J60
P60
J61
P61
J62
P62
HS10
HS11
HS12
HS13
HS14
HS15
HS16
HS17
HS18
HS19
HS35
HS36
HS25
HS26
WIRING DIAGRAM, SYSTEM, AVEA
51000-40839


COMPRESSOR DRIVER PCB 51000-40380 FROM SH 1,ZONE D4
HS7
HS8
HS3
HS2
HS1
HS5
HS4
HS6
HARNESS #5
MOTOR LITTON
COMPRESSOR
NOTE: FOR SERVO MAGNETICS MOTORS USE THIS CONFIGURATION -
HS1 - RED
HS2 - GREEN
HS3 - BLACK
HS4 - ORANGE
HS5-BROWN
HS6 - BLUE
HS7 -YELLOW
HS8 - GRAY
FROM POWER DRIVER TRANSITION PCB, JM4, SH 1, ZONE C4 & C5
PM1
JM1
ENHANCED PATIENT MONITORING PCB 51000-40330
FAW_AZ SOL
FAW_PRG SOL
FAW_PRG SOL
ESO_EVAC SOL
ESO_ISO SOL
ESO_FILL SOL
Paux SOL
LCD
LED PCB
BACKLIGHT PCB
CABLE ASSEMBLY CONTROL PCB TO LCD PCB 71681
CABLE ASSEMBLY CONTROL PCB TO LED PCB 51000-40681
51000-40687
FROM POWER DRIVER PCB, JP8, SH 1, ZONE B4
JP1
PP1
JP5
P5
ESPOHAGEAL/TRACHEAL CABLE ASSY 51000-40780
EPM TO HOT WIRE TRANSITION PCB 51000-40773
HOT WIRE TRANSITION PCB 51000-40440
TCA PCB TO HOT WIRE TRANSITION CABLE ASSY 51000-40776
TCA PCB 51000-40310
OXYGEN PRESS PCB 51000-40360
AIR PRESS PCB 51000-40360
BLENDED GAS PRESS PCB 51000-40370
71659
71659
71657
TOUCH SCREEN
CONTROL PCB ASSEMBLY 51000-40300
SCSI CABLE ASSEMBLY 51000-40698
O2 BLENDER PCB 51000-40290
INSP FLOW PCB 51000-40340
71658
71656
GAS TEMP CABLE ASSEMBLY 51000-40774
TCA PCB TO VARFLEX TRANSITION PCB 51000-40773
VARFLEX TRANSITION PCB 51000-40430
HOURMETER 51000-40700
51000-40834
51000-40835
NURSE CALL CABLE ASSY 51000-40772
OXYGEN SENSOR CABLE ASSY 51000-40759
GAS ID CABLE ASSY 51000-40833
ANALOG OUTPUTS
SAFETY SOLENOID
51000-40781
OVERLAY 51000-40193
SPARE SOL. 1
OPTICAL ENCODER JR2
RS232
PRINTER
RS232
MIB
VIDEO

51000-40839

Appendix C Specifications

Pneumatic Supply

Air or Heliox Supply

Pressure Range:	20 to 80 psig	(Supply Air)
	20 to 80 psig	(Supply Heliox)
	3 to 10 psig	(Compressor Air)
Temperature:	10 to 62 °C (50 to 143.6 °F)	
Humidity:	Dew Point of gas should be 1.7 °C (3 °F) below the ambient temperature (minimum)	
Minimum Flow:	80 L/MIN at 20 psig	
Inlet Fitting:	CGA DISS-type body, No. 1160	(Air)
	CGA DISS-type body, No. 1180	(Heliox)

Oxygen Supply

Pressure Range:	20 to 80 psig	(Supply Oxygen)
Temperature:	10 to 40 °C (50 to 104 °F)	
Humidity:	Dew Point of gas should be 1.7 °C (3 °F) below the ambient temperature (minimum)	
Minimum Flow:	80 L/MIN at 20 psig	
Inlet Fitting:	CGA DISS-type body, No. 1240	

Electrical Supply

AC Power Supply

The ventilator operates within specification when connected to the following AC power supplies:

Nominal	Voltage Range	Frequency Range
100 VAC	(85 to 110 VAC)	47 to 65 Hz
120 VAC	(102 to 132 VAC)	55 to 65 Hz
230 VAC	(196 TO 253 VAC)	47 to 65 Hz
240 VAC	(204 TO 264 VAC)	47 to 65 Hz

DC Power Supply

The ventilator can also operate from a 24 VDC power source (internal or external battery).

Internal Battery:

The ventilator operates within specification for a minimum duration of 30 minutes when operated on the internal battery. Maximum charge time to achieve a full charge is 8 to 12 hours.

External Battery:

22.0 to 26.4 VDC

Data Input / Output

Analog Inputs

The ventilator provides up to 8 programmable channels for analog signal inputs. Each channel shall be scalable for the input ranges specified.

Ranges:	0 to 1 VDC
	0 to 5 VDC
	0 to 10 VDC
Resolution:	0.25 mV (for 0 to 1 VDC)
	1.37 mV (for 0 to 5 VDC)
	2.5 mV (for 0 to 10 VDC)

Analog Outputs

The ventilator provides 4 signals to the analog output connector:

1. Airway Pressure, P_{AW}:

Connection	DB25 connector, pin 22. Ground pins 9-13
Range:	-60 to 140 cmH_2O
Scale:	1 cmH_2O/25 mV
Accuracy:	± 50 mV or ± 5% of reading, whichever is greater
Zero Offset:	1.5 VDC at 0 cmH_2O

2. Flow

Connection DB25 connector, pin 23. Ground pins 9-13

Inspiratory/Expiratory flow:

When selected, the ventilator provides a continuous analog voltage representative of inspiratory flow minus expiratory flow.

Range:	-300 to 200 L/MIN (Adult)
	-120 to 80 L/MIN (Pediatric)
	-60 to 40 L/MIN (Neonate)
Scale Factor:	1 L/MIN / 10 mV (Adult)
	1 L/MIN / 25 mV (Pediatric)
	1 L/MIN / 50 mV (Neonate)
Accuracy:	± 10% of reading or ± 30 mV, whichever is greater

Zero Offset: 3.0 VDC at 0 L/MIN

Machine:

When selected the ventilator provides a continuous analog voltage representative of machine delivered flow.

Range:	0 to 200 L/MIN	(Adult)
	0 to 100 L/MIN	(Pediatric)
	0 to 50 L/MIN	(Neonate)
Scale Factor:	1 L/MIN / 25 mV	(Adult)
	1 L/MIN / 50 mV	(Pediatric)
	1 L/MIN / 100 mV	(Neonate)
Accuracy:	± 10% of reading or ± 30 mV, whichever is greater	
Zero Offset:	None	

3. Volume:

Connection	DB25 connector, pin 24. Ground pins 9-13	
Range:	-1.00 to 4.00 L	(Adult)
	-200 to 800 mL	(Pediatric)
	-100 to 400 mL	(Neonate)
Scale Factor:	1 L / V	(Adult)
	1 mL / 5 mV	(Pediatric)
	1 mL / 10 mV	(Neonate)
Accuracy:	± 10% of reading or ± 30 mV, whichever is greater	
Zero Offset:	1.000 VDC	

4. Breath Phase

Connection DB25 connector, pin 25. Ground pins 9-13.

The ventilator provides a continuous analog voltage representative of breath phase (Inspiration = 5 VDC, Expiration = 0 VDC).

Digital Communication

The ventilator has two RS-232 ports for bi-directional communication of data: RS-232 Ch1 and RS-232 Ch2.

Printer

The ventilator has a standard 25-pin female Centronics parallel printer port for interfacing to an external printer.

Remote Nurse Call

The ventilator has a modular jack configured to interface with external systems that are either wired for normally open (N.O., close on alarm) or normally closed (N.C., open on alarm) signals.

In the active state, the remote alarm can sink 1.0 A.

Independent Lung Ventilation (ILV)

The ventilator provides an output (master) and an input (slave) for synchronization of ventilators. The output supplies a 5 VDC logic signal synchronized to the breath phase of the master.

Video Output

The ventilator provides a video output connector which allows for interfacing to an externally located 256-color, 800 x 600, SVGA monitor.

Atmospheric & Environmental Specifications

Temperature and Humidity

Storage

Tenperature:	–20 to 60 °C (–4 to 140 °F)
Humidity:	0 to 95% RH non-condensing

Operating

Temperature:	5 to 40 °C (41 to 104 °F)
Humidity:	0 to 95% RH non-condensing

Barometric Pressure

760 to 545 mmHg

Physical Dimensions

Overall Size

Ventilator	17” W x 16” D x 10.5” H
UIM	16.25” W x 2.5” D x 13.75” H

Weight

Ventilator w/ UIM	≤ 73 lbs.
Compressor	≤ 7 lbs.

Accessories

Pall Microbial Filter

Resistance

The exhalation filter supplied with your AVEA ventilator is manufactured by Pall Medical of Ann Arbor, MI, USA. The published maximum resistance of this filter is 4 cmH2O at 20 L/min for the Intervene 255 Filter (small) and 4cm H2O at 100 L/min for the 725 (large) filter.

Compliance

The compliance for the small filter is < 0.5 ml/cmH2O and for the large filter is < 0.4 ml/cmH2O

Materials

Materials used in the contruction of both filters have passed USP Class VI 121° C Plastic and Cytoxicity test.

For further information please contact Pall Medical.

Water Trap

Resistance

The resistance of the small water trap assembly including the collection bottle is < than 0.25 cmH2O at 20 L/min.

Compliance

The compliance of both water trap assemblies including the collection bottle is < 0.2 ml/cmH2O.

Appendix D Data Communication Protocol

This document defines the data content, message formats and communication protocols for direct access to digital data on the AVEA ventilator.

It is intended for software engineers developing software for the AVEA and any third party who may wish to accept or exchange digital data with the AVEA ventilator.

The information contained herein pertains to data and communication for AVEA Software releases V2.11 and higher, except where superceded by subsequent revisions of this document.

Overview

This document describes serial data communication between the AVEA ventilator and a host computer.

The host provides information to the ventilator to request data or change transmission characteristics.

The ventilator sends data to the host when requested, or if so configured, as new data becomes available.

Data types available from the ventilator include;

- Settings Data
- Digital Monitored Data
- Alarm and Status Data
- Scalar (Waveform) Data

Data transmission is via a packet format protocol. The following sections describe the electrical connection requirements, the format of the data packets, and the sequence of transmission and/or exchange.

Physical Requirements

Connection Cable

The electrical connection shown in Figure 1 is required to connect to a typical Personal Computer. Although this cable configuration is not readily available off the shelf, it can easily be constructed from off the shelf components.

Recommended is a 9-pin F-F serial Null Modem Cable with a 9-pin M-M gender adapter on the AVEA end.

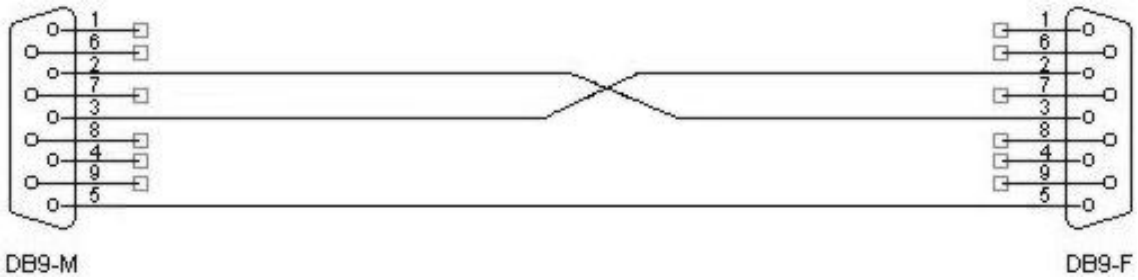


Figure D.1

Communication Settings

The communication settings should be set to the following:

Baud Rate:	38400
Data Bits:	8
Parity:	None
Stop Bits:	1
Flow Control:	None

Limitations

Communication with the AVEA Ventilator is subject to the following limitations:

- Scalar data cannot be enabled at Baud rates of less than 38400.
- All data transmission may be disabled under certain circumstances, for example, if an alternate data channel (MIB) is selected for communication.
- The Baud rate is currently fixed at 38400.

Packet Format

Packet

STX	Payload	CheckSum

STX

Definition:	Start of transmission per ASCII.
Size:	One (1) byte.
Value:	2 decimal, 02h Hexadecimal.

Payload

Definition:	Object of the transmission; desired message content.
Size:	Varies.
Value:	N/A

CheckSum

Definition:	Simple one's complement of sum of all bytes in the Payload.
Size:	One (1) byte.
Value:	Per Definition.

Payload

Header	Body

Header

Reserved	ID	Body Size

Size: Four (4) bytes; unsigned 32-bit integer (bitfield); little endian.

Value: N/A.

Reserved

Definition: Reserved for manufacturer's use.

Size: One (1) byte; (bitfield 24:31).

Value: N/A.

ID

Definition: Identifies type of message body.

Size: One (1) byte; (bitfield 16:23).

Value:

PRIMARY SETTINGS DATA:	0
ADVANCED SETTINGS DATA:	1
ALARM SETTINGS DATA:	2
PATIENT SETTINGS DATA:	3
OPERATIONAL SETTINGS DATA:	4
CONFIG SETTINGS DATA:	5
DIGITAL MONITOR DATA:	6
ALARMS AND STATUS DATA:	7
SCALAR (WAVEFORM) DATA:	8
SERVICE REQUEST:	9
SERVICE REQUEST REPLY:	10

Body Size

Definition: Total number of 32-bit word equivalents (bytes /4) in the Body of the Payload (i.e., excluding Header). Body Size must always be evenly divisible by 4.

Size: Two (2) bytes; unsigned 16-bit integer; (bitfield 0:15); little endian.

Value: Varies.

Body

Definition: A specific structure and type of transmitted data; one of the following sections.

Size: Varies. See definitions below.

Value: N/A

Service Request

Definition: Identifies a request for data or change in service. Sent from the Host to the Ventilator to request data of a certain type, or to request a change to the transmit mode.

Body Size: 1 word (4 bytes); unsigned 32-bit integer; little endian.

Value:

REQUEST PRIMARY SETTINGS DATA:	0
REQUEST ADVANCED SETTINGS DATA:	1
REQUEST ALARM SETTINGS DATA:	2
REQUEST PATIENT SETTINGS DATA:	3
REQUEST OPERATIONAL SETTINGS DATA:	4
REQUEST CONFIGURATION SETTINGS DATA:	5
REQUEST DIGITAL MONITOR DATA:	6
REQUEST ALARMS AND STATUS DATA:	7
SET MONITOR MODE=REQUEST:	8
SET MONITOR MODE=AS AVAILABLE:	9
SET ALARM AND STATUS MODE=REQUEST:	10
SET ALARM AND STATUS MODE=AS AVAILABLE:	11
SET SCALAR MODE=DISABLED:	12
SET SCALAR MODE=AS AVAILABLE:	13

Service Request Reply

Definition: Response to a Service Request. This reply is only sent if there is no other natural response to the request. Requests for data are replied with the data. Request for a change in service would receive a Service Request Reply. If the request was successful, the same value of the Service Request is replied. If the request cannot be satisfied for any reason, the one's complement of the Service Request value is replied.

Body Size: 1 word (4 bytes); unsigned 32-bit integer; little endian.

Value: If Successful, Value = Service Request Value;

If NOT Successful, Value = ~(Service Request Value).

Primary Settings Data

1st 14th

Rate	Vt	Pinsp	Finsp	Ti	Pause	PSV	PEEP	Ftrig	FiO2	Phigh	Thigh	Tlow	Plow

Definition:

Rate	bpm	Breath rate (Rate)
Vt	mL x10	Tidal Volume (Volume)
Pinsp	cmH2O	Inspiratory Pressure (Insp Pres)
Finsp	L/min x10	Inspiratory Flow (Insp Flow)
Ti	sec x100	Inspiratory Time (Insp Time)
Pause	sec x100	Inspiratory Pause (Insp Pause)
PSV	cmH2O	Pressure Support Ventilation level (PSV)

PEEP	cmH2O	PEEP (PEEP)
Ftrig	L/min x10	Flow Trigger Sensitivity (Flow Trig)
FiO2	%	Fractional Inspiratory Oxygen (FiO2)
Phigh	cmH2O	Pressure High, APRV/BiPhasic (Pres High)
Thigh	sec x10	Time High, APRV/BiPhasic (Time High)
Tlow	sec x10	Time Low, APRV/BiPhasic (Time Low)
Plow	cmH2O	Pressure Low, APRV/BiPhasic (Pres Low)

Body Size: 7 words (28 bytes). Each field, signed 16-bit integer; little endian.

Value: Per definition.

Advanced Settings Data

1st

Fbias	Vmach	Vlimit	Trise	Fcycle	Trise psv	Fcycle psv	Tmax psv

16th

Wave	Sigh	Ptrig	Vsync	Trise Vsync	Tsync high	Tsync low	PSVhigh

Definition:	Fbias	L/min x10	Bias Flow (Bias Flow)
	Vmach	mL x10	Machine Volume (Mach Vol)
	Vlimit	mL x10	Volume Limit (Vol Limit)
	Trise	1..9	Pressure Control Rise Time (Rise Time)
	Fcycle	% ?5	Flow Cycle % of PIFR (Flow Cycle)
	Trise-psv	1..9	PSV Rise Time (PSV Rise)
	Fcycle-psv	%	PSV Flow Cycle % of PIFR (PSV Cycle)
	Tmax-psv	sec x100	PSV Maximum Inspiratory Time (PSV Tmax)
	Wave	0/1	Decelerating Flow Volume Waveform OFF/ON (Waveform)
	Sigh	0/1	Sigh Volume Breath OFF/ON (Sigh)
	Ptrig	cmH2O x10	Pressure Trigger Sensitivity (Pres Trig)
	Vsync	0/1	Vsync mode OFF/ON (Vsync)
	Trise-Vsync	1..9	Vsync Rise Time (Vsync Rise)
	Tsync-high	%	Sync Window % of APRV/BiPhasic Time High (T High Sync)
	Tsync-low	%	Sync Window % of APRV/BiPhasic Time Low (T Low Sync)
	PSVhigh	0/1	PSV OFF/ON with APRV/BiPhasic Pres High(T High PSV)

Body Size: 8 words (32 bytes). Each field, signed 16-bit integer; little endian.

Value: Per definition.

Alarm Settings Data

1st				5th
High P_{peak}	Low P_{peak}	High V_e	Low V_e	High V_{te}

6th				10th
Low V_{te}	Low PEEP	High Rate	Apnea	Reserved

Definition:	High P_{peak}	cmH_2O	High Peak Pressure (High Ppeak)
	Low P_{peak}	cmH_2O	Low Peak Pressure (Low Ppeak)
	High V_e	L x100	High Minute Volume (High Ve)
	Low V_e	L x100	Low Minute Volume (Low Ve)
	High V_{te}	mL x10	High Tidal Volume (High Vte)
	Low V_{te}	mL x10	Low Tidal Volume (Low Vte)
	Low PEEP	cmH_2O	Low PEEP (Low PEEP)
	High Rate	bpm	High Breath Rate (High Rate)
	Apnea	sec	Apnea Interval (Apnea Interval)
	Reserved	N/A	Reserved for manufacturer's use.

Body Size: 5 words (20 bytes). Each field, signed 16-bit integer; little endian.

Value: Per definition.

Configuration Settings Data

1st						6th
Lang	Alm FiO2	Aout	ILV Mode	Ain Gain	Pbaro	

Body Size: 4 words (16 bytes); each field see below.

Value: N/A.

Lang (Language)

Definition: Language Selection for User Interface.

Size: Four (4) bytes; unsigned 32-bit integer; little endian.

Value:	ENGLISH	0
	FRENCH	1
	GERMAN	2
	ITALIAN	3
	PORTUGUESE	4
	SPANISH	5

Alm FiO2 (O2 Alarm)

Definition: Enable/Disable setting of FiO2 Alarm.

Size: Two (2) bytes; unsigned 16-bit integer; little endian.

Value:	ENABLED	0
	DISABLED	1

Aout (Analog Output Type)

Definition:	Selection of Flow Waveform for Analog Output.	
Size:	Two (2) bytes; unsigned 16-bit integer; little endian.	
Value:	Wye Flow	0
	Machine Flow	1

ILV Mode (ILV Mode)

Definition:	Independent Lung Ventilation configuration of ventilator.	
Size:	Four (4) bytes; unsigned 32-bit integer; little endian.	
Value:	ILV OFF	0
	ILV MASTER	1
	ILV SLAVE	2

Ain Gain(Analog Input Gain)

Definition:	Selection of Amplifier Gain applied to Analog Inputs.	
Size:	Two (2) bytes; unsigned 16-bit integer; little endian.	
Value:	High Gain; 0-1V	0xFFFF
	Med. Gain; 0-5V	0xAAAA
	Low Gain; 0-10V	0x0000

Pbaro (Baro Pres)

Definition:	Barometric pressure setting of ventilator environment.
Size:	Two (2) bytes; signed 16-bit integer; little endian.
Value:	Per definition; mmHg.

Operational Settings Data

1st						7th
Mode	AAC	ETT Len	ETT Dia	Leak Comp	CCC k	Humid

Body Size:	4 words (16 bytes); each field see below.	
Value:	N/A.	

Mode (Mode)

Definition:	Breath delivery Mode setting.	
Size:	Four (4) bytes; unsigned 32-bit integer; little endian.	
Value:	Not Specified	0
	APRV/BiPhasic; Volume Control Apnea Backup	1
	APRV/BiPhasic; Pressure Control Apnea Backup	2
	PRVC SIMV	3
	PRVC Assist/Control	4
	CPAP; TCPL Apnea Backup	5

	TCPL SIMV	6
	TCPL Assist/Control	7
	CPAP; Pressure Control Apnea Backup	8
	Pressure SIMV	9
	Pressure Assist/Control	10
	CPAP; Volume Control Apnea Backup	11
	Volume SIMV	12
	Volume Assist/Control	13

AAC (AAC)

Definition: Automatic Airway Compensation Enable/Disable.

Size: Two (2) bytes; unsigned 16-bit integer; little endian.

Value: DISABLED 0

ENABLED 1

ETT Len (Length)

Definition: Endotracheal Tube Length.

Size: Two (2) bytes; signed 16-bit integer; little endian.

Value: Per definition; cm x10

ETT Dia (Diameter)

Definition: Endotracheal Tube Diameter.

Size: Two (2) bytes; signed 16-bit integer; little endian.

Value: Per definition; mm x2

Leak Comp (Leak Comp)

Definition: System Leak Compensation Enable/Disable.

Size: Two (2) bytes; unsigned 16-bit integer; little endian.

Value: DISABLED 0

ENABLED 1

CCC k (Circuit Compliance)

Definition: Constant (k) for enabling Circuit Compliance Compensation.

Size: Two (2) bytes; signed 16-bit integer; little endian.

Value: Per definition; mL/cmH2O x10.

Humid (Humidifier)

Definition: Active Humidifier Enable/Disable.

Size: Two (2) bytes; unsigned 16-bit integer; little endian.

Value: DISABLED 0

ENABLED 1

Patient Settings Data

1st 4th

Patient Size

Pt Weight

Patient ID

Reserved

Body Size: 10 words (40 bytes); each field see below.

Value: N/A.

Patient Size (Patient Size)

Definition: Patient Size setting.

Size: Four (4) bytes; unsigned 32-bit integer; little endian.

Value: NEO 0

PED 1

ADULT 2

Pt Weight (Pt Weight)

Definition: Patient Weight (Ideal Body Weight) setting for normalizing monitors.

Size: Two (2) bytes; signed 16-bit integer; little endian.

Value: Per definition; kg x100.

Patient ID (Patient ID)

Definition: Patient Identification setting.

Size: 32 bytes; ASCII zero terminated string.

Value: N/A

Reserved

Definition: Reserved for manufacturer's use.

Size: Two (2) bytes.

Value: N/A

Digital Monitor Data

1st 10th

Vte	Vte/kg	Vti	Vti/kg	Spon Vte	Spon Vte/kg	Mand Vte	Mand Vte/kg	Vdel	Leak

11st 20th

Ve	Ve/kg	Spon Ve	Spon Ve/kg	Total Rate	Spon Rate	Ti	Te	I:E	RSBI

21st 30th

Ppeak	Pmean	Pplat	PEEP	Pair	PO2	FiO2	Cdyn	Cdyn/kg	Cstat

31st 35th

Cstat/kg	C/C20	Rrs	PIFR	PEFR

Definition:

*Vte	L x100,000,000	Expiratory Tidal Volume
Vte/kg	mL/kg x100	Expiratory Tidal Volume, Normalized
*Vti	L x100,000,000	Inspiratory Tidal Volume
Vti/kg	mL/kg x100	Inspiratory Tidal Volume, Normalized
*Spon Vte	L x100,000,000	Spontaneous Tidal Volume
Spon Vte/kg	mL/kg x100	Spontaneous Tidal Volume, Normalized
*Mand Vte	L x100,000,000	Mandatory Tidal Volume
Mand Vte/kg	mL/kg x100	Mandatory Tidal Volume, Normalized
*Vdel	L x100,000,000	Machine Delivered Volume
Leak	%	(Vti - Vte)/Vti x100
Ve	L x100	Minute Volume
Ve/kg	mL/kg	Minute Volume, Normalized
Spon Ve	L x100	Spontaneous Minute Volume
Spon Ve/kg	mL/kg	Spontaneous Minute Volume, Normalized
Total Rate	bpm	Total Breath Rate
Spon Rate	bpm	Spontaneous Breath Rate
Ti	sec x100	Inspiratory Time
Te	sec x100	Expiratory Time
†I:E	unitless… x10	Inspiratory/Expiratory Time Ratio
RSBI	b2/min/L	Rapid Shallow Breathing Index
Ppeak	cmH2O	Peak Airway Pressure
Pmean	cmH2O	Mean Airway Pressure
Pplat	cmH2O	Plateau Pressure
PEEP	cmH2O	Positive End Expiratory Pressure
Pair	psig	Air Supply Pressure
PO2	psig	Oxygen Supply Pressure
FiO2	%	Fractional Inspiratory Oxygen
Cdyn	mL/cmH2O x100	Dynamic System Compliance
Cdyn/kg	mL/cmH2O/kg x100	Dynamic System Compliance, Normalized
Cstat	mL/cmH2O x100	Static System Compliance
Cstat/kg	mL/cmH2O/kg x100	Static System Compliance, Normalized
C/C20	unitless… x100	Compliance ratio
Rrs	cmH2O/L/sec x100	Respiratory System Resistance
PIFR	L/min x10	Peak Inspiratory Flow Rate
PEFR	L/min x10	Peak Expiratory Flow Rate

Body Size: 20 words (80 bytes). Each field, signed 16-bit integer, little endian, except as noted (*).

* signed 32-bit integer; little endian.

Value: Per definition, except as noted (†)

†For field value x: if x ≥ 0, I:E = " x : 1"; otherwise I:E = "1 : | x |"

Alarm and Status Data

1st 8th

State	Alarms	Activity	Connect	Inop Faults	Alert Faults	Log Faults	Hours

Body Size: 8 words (32 bytes); each field see below.

Value: N/A.

State

Definition: Ventilator operating State.

Size: Four (4) bytes; unsigned 32-bit integer; little endian.

Value:

STARTING	0
SERVICE	1
DIAGNOSTIC	2
NORMAL	3
STANDBY	4
POWERDOWN	5

Alarms

Definition:

Vent Inop	Bit 0
Loss of Gas	Bit 1
Circuit Disconnect	Bit 2
Ext High Ppeak	Bit 3
Safety Valve	Bit 4
High Ppeak	Bit 5
Apnea Interval	Bit 6
Loss of O2	Bit 7
Loss of Air	Bit 8
Loss of Heliox	Bit 9
Low Battery	Bit 10
Loss of A/C	Bit 11
Low PEEP	Bit 12
Low Ppeak	Bit 13

Low Vte	Bit 14
Low Ve	Bit 15
Low FiO2	Bit 16
High FiO2	Bit 17
ILV Disconnect	Bit 18
Alarm Test	Bit 19
Invalid Gas ID	Bit 20
High Ve	Bit 21
High Rate	Bit 22
Insp Time Limit	Bit 23
I:E Limit	Bit 24
Fan Failure	Bit 25
High Vte	Bit 26
Volume Limit	Bit 27
Unused	Bit 28:31

Size: Four (4) bytes; unsigned 32-bit integer; bitfield (0:31); little endian.

Value:

Inactive	0
Active	1

Activity

Definition:

Audible Alarm Silence	Bit 0
Increase FiO2	Bit 1
Suction Procedure	Bit 2
Nebulizer	Bit 3
Compressor	Bit 4
AAC	Bit 5
Vsync	Bit 6
Machine Volume	Bit 7
Inspiratory Hold	Bit 8
Expiratory Hold	Bit 9
Manual Breath	Bit 10
Unused	Bit 11:31

Size: Four (4) bytes; unsigned 32-bit integer; bitfield(0:31); little endian.

Value:

Inactive	0
Active	1

Connect

Definition:

Inspiratory Flow Sensor	Bit 0
Expiratory Flow Sensor	Bit 1
Adult Wye Flow Sensor	Bit 2
Neonatal Wye Flow Sensor	Bit 3
Hotwire Wye Flow Sensor	Bit 4
Proximal Pressure Line	Bit 5
Esophageal Pressure Line	Bit 6
Tracheal Pressure Line	Bit 7
Heliox Gas ID	Bit 8
Compressor	Bit 9
Extended Pressure Monitor	Bit 10
Unused	Bit 11:31

Size: Four (4) bytes; unsigned 32-bit integer; bitfield(0:31); little endian.

Value: Not Detected/Not Ready 0

Connected/Ready 1

Inop Faults

Definition:

Pneumatics Module FTC	Bit 0
HSSC Comm Fault	Bit 1
IFS Voltage Fault	Bit 2
TCA A/D Ref Fault	Bit 3
IFS A/D Ref Fault	Bit 4
FCV Overcurrent Fault	Bit 5
DPRAM Comm Error, Mntr	Bit 6
DPRAM Comm Error, Ctrl	Bit 7
Data Error, TCA	Bit 8
Bad Cal, EFS PT	Bit 9
Bad Cal, Insp PT	Bit 10
Bad Cal, Exp PT	Bit 11
Data Error, Blender	Bit 12
Bad Cal, Blender	Bit 13
Data Error, Air Sup PT	Bit 14
Bad Cal, Air Sup PT	Bit 15
Data Error, O2 Sup PT	Bit 16
Bad Cal, O2 Sup PT	Bit 17

Data Error, BG PT	Bit 18
Bad Cal, BG PT	Bit 19
Device Not Found, IFS	Bit 20
Header Error, IFS	Bit 21
Data Error, IFS	Bit 22
Bad ID, IFS	Bit 23
Bad Cal, IFS	Bit 24
Device Not Found, EFS	Bit 25
Header Error, EFS	Bit 26
Data Error, EFS	Bit 27
Bad ID, EFS	Bit 28
Bad Cal, EFS	Bit 29
Bad Cal, FCV	Bit 30
Unused	Bit 31

Size: Four (4) bytes; unsigned 32-bit integer; bitfield(0:31); little endian.

Value: Inactive 0

Active 1

Alert Faults

Definition:

Bad Model Number	Bit 0
Bad Cal, FiO2	Bit 1
Header Error, Compressor	Bit 2
Data Error, Compressor	Bit 3
Bad Cal, Compressor	Bit 4
Invalid Feature, EPM	Bit 5
Header Error, EPM	Bit 6
Data Error, EPM	Bit 7
Bad Cal, WFS PT	Bit 8
Bad Cal, Esoph PT	Bit 9
Bad Cal, Aux PT	Bit 10
Bad Sensor Type, HWFS	Bit 11
Header Error, HWFS	Bit 12
Data Error, HWFS	Bit 13
Bad ID, HWFS	Bit 14
Bad Cal, HWFS	Bit 15
Header Error, WFS	Bit 16

Data Error, WFS	Bit 17
Bad ID, WFS	Bit 18
Bad Cal, WFS	Bit 19
Settings Lost	Bit 20
Config Lost	Bit 21
Insp Temperature Error	Bit 22
Exp Temperature Error	Bit 23
Compressor Rotor Locked	Bit 24
Compressor Output Low	Bit 25
Esoph Balloon Leak Test Failed	Bit 26
Bad AutoZero, IFS	Bit 27
Bad AutoZero, EFS	Bit 28
Bad AutoZero, WFS	Bit 29
Unused	Bit 30:31

Size: Four (4) bytes; unsigned 32-bit integer; bitfield(0:31); little endian.

Value: Inactive 0

Active 1

Log Faults

Definition:

Bad ID, Ctrl PCB	Bit 0
Header Error, Ctrl PCB	Bit 1
Bad ID, TCA	Bit 2
Header Error, TCA	Bit 3
Bad ID, Power PCB	Bit 4
Header Error, Power PCB	Bit 5
Bad ID, Blender	Bit 6
Header Error, Blender	Bit 7
Bad ID, Air Supply PT	Bit 8
Header Error, Air Sup PT	Bit 9
Bad ID, O2 Supply PT	Bit 10
Header Error, O2 Sup PT	Bit 11
Bad ID, BG PT	Bit 12
Bad Header, BG PT	Bit 13
Trend Data Lost	Bit 14
Event Log Data Lost	Bit 15
Compressor Runtime Data Error	Bit 16

Unused	Bit 17:31

Size: Four (4) bytes; unsigned 32-bit integer; bitfield(0:31); little endian.

Value: Inactive 0

Active 1

Hours

Definition: Total hours of ventilator operation.

Size: Four (4) bytes; unsigned 32-bit integer; little endian.

Value: Per definition, Hours x100.

Scalar (Waveform) Data

ScalarData[10]

Body Size: 60 words (240 bytes); each block see below.

Value: N/A.

Each ScalarData[n] contains:

1st											12th
Metrics	Paw	Pinsp	Flow	Vol	Pes	Ptr	Fexp	Finsp	A0	A1	Reserved

Block Size: 24 bytes; each field see below.

Value: N/A.

Metrics

15:7	6:5	4:3	2:0
Reserved	Trigger	Type	Phase

Definition: Metrics pertaining to scalar data.

Size: Two (2) bytes; unsigned 16-bit integer (bitfield); little endian.

Value: N/A.

Reserved

Definition: Reserved for manufacturer's use.

Size: 9 bits; bitfield 7:15.

Value: N/A.

Trigger

Definition: Breath Trigger Source.

Size:	2 bits; bitfield 5:6.	
Value:	PATIENT	0
	VENTILATOR	1

Type

Definition:	Breath Type.	
Size:	2 bits; bitfield 3:4.	
Value:	NOT SPECIFIED	0
	SPONANEOUS	1
	MANDATORY	2
	SPECIAL	3

Phase

Definition:	Breath Phase.	
Size:	3 bits; bitfield 0:2.	
Value:	NOT SPECIFIED	0
	INSPIRATORY	1
	EXPIRATORY	2
	INSPIRATORY PAUSE	3
	EXPIRATORY PAUSE	4

Paw, Pinsp, Flow, Vol, Pes, Ptr, Fexp, Finsp, A0, A1

Definition:

Paw	cmH2O x100	Airway Pressure
Pinsp	cmH2O x100	Inspiratory Pressure
Flow	L/min x100	Airway Flow
Vol	L x10000	Tidal Volume
Pes	cmH2O x100	Esophageal Pressure
Ptr	cmH2O x100	Tracheal Pressure
Fexp	L/min x100	Expiratory Sensor Flow
Finsp	L/min x100	Inspiratory Sensor Flow
A0	mV	Analog Input Channel Zero
A1	mV	Analog Input Channel One

Size: Each field, Two (2) bytes; signed 16-bit integer; little endian.

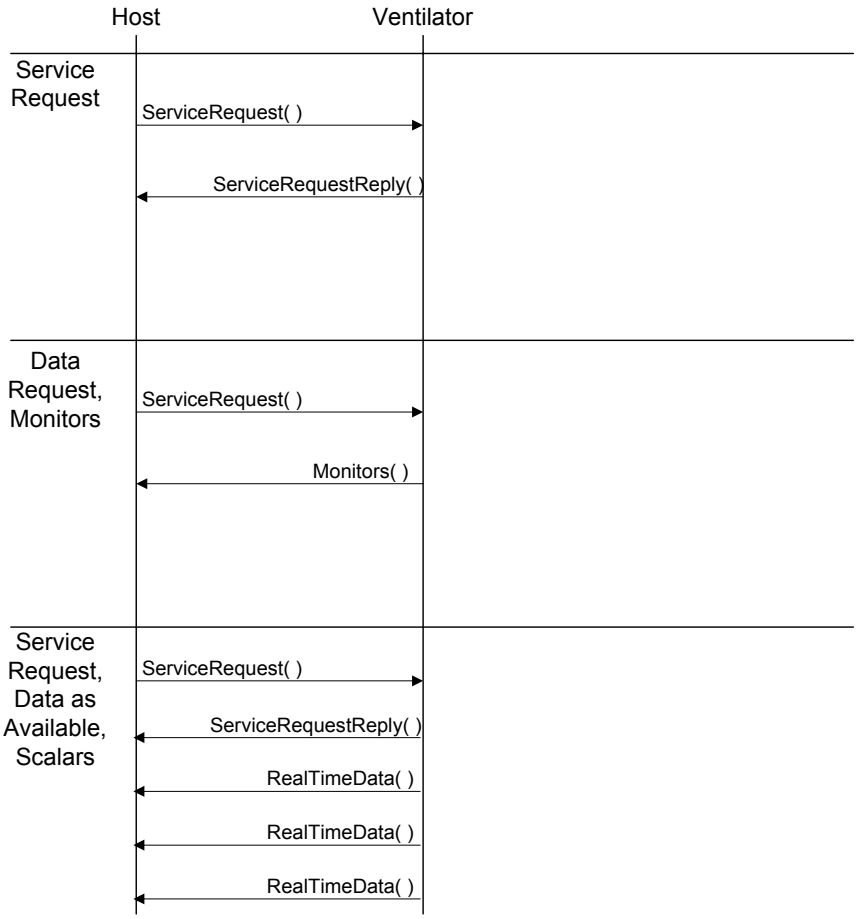
Value: Per definition.

Reserved

Definition:	Reserved for manufacturer's use.
Size:	Two (2) bytes; signed 16-bit integer; little endian.
Value:	N/A.

Exchange Protocol

The following describes several typical transaction sequences for this protocol. Others are possible, but are analogous to or extensions of those presented.



Default

The default transmission mode for all data types is "By Request".

Disabled State

All data transmission may be disabled under certain circumstances, for example, if an alternate data channel (MIB) is selected for communication. In this case, all Service

Requests will be replied with a failure message.

Service Request

This type of transaction sets the transmission characteristics. A Service Request message is sent from the host and is replied to from the ventilator with a Service Request Reply.

The reply indicates success or failure of the request.

Data Request

This type of transaction asks for data to be sent to the host. A Service Request message is sent from the host and is replied to from the ventilator with a packet of data of the type requested, or if the request cannot be satisfied, a Service Request Reply indicating failure. One packet of data is sent per request.

Data as Available

Once a successful Service Request to change transmission mode to "As Available" has been received by the ventilator, data will be sent to the host as new data becomes available without further requests from the host. Each data type available must have an individual request for the transmission mode to be changed. Settings data types may not be set to "As Available" and must be requested by the host each time they are required. For reference only, approximate data rates for each type are as follows:

- Monitors: End of each breath cycle, or 10 seconds, whichever comes first.
- Alarms/Status: 250ms intervals
- Scalars: 100ms intervals

Glossary

Breath Interval	Elapsed time from the start of one breath to the start of the next.
Preset	An operator set ventilator parameter.
Trigger	Value at which the ventilator initiates delivery of a breath as a result of measured patient effort.
BTPS	Body Temperature at Ambient Pressure, Saturated.
ATPD	Ambient Temperature, Ambient Pressure, Dry.
Demand Flow	The flow generated by the ventilator to meet the patient's flow demand in order to maintain PEEP at the preset level.
DVM	Digital Volt Meter
PEEP	Positive End Expiratory Pressure.
AC	Alternating Current (mains electricity).
Bias Flow	A continuous flow through the patient breathing circuit. The level of Bias Flow can be set from .4 to 5 L/min
Bpm	Breaths per minute.
Breath Period	The length of time between machine-initiated breaths. Depends on the Breath Rate setting and is computed by dividing 60 seconds by the Breath Rate setting. When the Breath Rate setting is 15 bpm, for example, the breath period is four seconds (i.e., 60 / 15). In this example, the ventilator initiates a breath every four seconds.
Breath Rate	The number of breaths delivered in a minute.
BTPD	Body Temperature at Ambient Pressure, Dry
Button	A push button switch used to toggle a function on or off.
cmH2O	Centimeters of water pressure.
Controls	Any button, switch, or knob that allows you to modify the ventilator's behavior.
Event	An anomalous condition that occurs during ventilator operation.
Flow	The rate at which gas is delivered. Measured in liters per minute (L/min).
Indicators	A visual element showing operational status.
L	Liters. A unit of volume.
LED	Light Emitting Diode
L/min	Liters per minute. A unit of flow.
Mode	An operating state of the ventilator that determines the allowable breath types.
Monitored Parameter	A measured value displayed in the monitor window.

O2	Oxygen
Patient Breathing Circuit	The tubing that provides the ventilatory interface between the patient and ventilator.
Paw	Airway Pressure. Measured in cmH2O at the exhalation valve.
PEEP	See Positive End Expiratory Pressure.
PIP	Peak Inspiratory Pressure . Shows the highest circuit pressure to occur during inspiration as measured at the exhalation valve. The display is updated at the end of inspiration. PIP is not updated for spontaneous breaths.
Pplat	Plateau Pressure. Measured during an Inspiratory Hold maneuver. Used to calculate Static Compliance. (Cst).
PSIG	Pounds per square inch gauge. 1 PSIG = .07bar
Sigh Breath	A Volume Controlled machine breath having a tidal volume equal to one-and-a-half times (150%) of the current tidal volume setting.
User Verification Tests (UVT)	A group of tests to check ventilator performance prior to connecting the ventilator to a patient.
WOB	Patient Work of Breathing i.e. a measure of Patient Effort.

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